NOTES ON THE

MANUFACTURE OF EARTHENWARE

NOTES ON THE MANUFACTURE OF EARTHENWARE

BY

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WITH NUMEROUS ILLUSTRATIONS

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PREFACE.

The scope of these notes does not admit of an historical essay nor a chemical treatise on the varied materials and combinations used in Ceramics; and to those who wish to have a thorough knowledge of these subjects, no works can be more highly recommended than M. Alex. Brogniart's *Traité des Arts céramiques ou des Potteries*, and M. M. A. Sálvetat's *Leçons de céramique*. There are many other works from which much useful information can be obtained, such as Shaw's *Chemistry of Pottery*; Musprat's *Chemistry as applied to Arts and Manufactures*; Spon's *Encyclopædia of Industrial Arts*; *Pottery*, L. Arnoux; *La Porcelaine*, Dubreuil; *History of Pottery*, Marryat; *Die Thonindustrie Zeitung* — *The Pottery Gazette*, &c., &c., to many of which the early chapters of these notes are indebted—and my thanks must also be expressed to Mr. Saml. Sant for some additional notes and for the trouble taken in revising the first proofs, as also to Messrs. Wm. Boulton, Ltd., the eminent pottery machinery engineers, for their courtesy in permitting the use of many of their designs of machinery. I can do no better than quote M. Brogniart's opening remarks in his preface to the first edition: "I know no industry," he says, "that affords in its practice, in its theory, or in its history, so many interesting considerations in the wealth of its scientific and economic application, as the ceramic

art or the manufacture of vessels and utensils out of baked earth. Nor do I know one that offers productions more simple, more varied, more easy to make, or more durable in spite of their fragile construction. In no other human product are so many qualities united." It is not proposed to attempt to teach a trade; that is not learnt from books, but only by constant application to the details of the manufacture in actual practice. The potter, unfortunately, unlike the poet, is made, not born. It is hoped, however, that these notes may be of some use to apprentices, students, and to those who are about to take up earthenware-potting as a trade, and to induce them to study the great works that have from time to time appeared on this and kindred subjects; and the apology for many trivial matters mentioned in the course of these notes must be that details which are scarcely noticed by those who are constantly in contact with them, and which form part of their daily life, though quite simple and uninteresting to them, are full of interest and significance to the inquiring mind of the novice. Should anything be found that is of interest or service to those already proficient in their trade, then my object is indeed more than attained.

NOTE TO THE SECOND IMPRESSION.

THE continued demand for this little book, which has been out of print for some years, has induced the Publishers, with the consent of the Author, to issue a second impression of it.

The Author having neither the time nor the inclination to undertake the task of revision, and the main principles of the industry remaining unaltered, the book appears substantially as it was written in 1901.

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NOTES ON THE
MANUFACTURE OF EARTHENWARE.

INTRODUCTORY NOTE.

EARTHENWARE is one of the many divisions of ceramic art, under which generic title may be classed all the gradations, from the coarsest brick to the finest porcelain, including bricks, tiles, terra-cotta, delft, earthenware, stoneware, china, and porcelain. Though the two words ceramics and pottery are derived from a somewhat similar idea, the former seems to have obtained a wider signification, embracing the latter as a sub-division. The word *ceramic* is derived from the Greek *κέραμος*, which meant the horn of an animal, and then acquired the meaning of a drinking cup, and as doubtless the first earthen cups were made in the shape of horns the same name was applied to them, and afterwards spread to all the products of the potter's art. In like manner *pottery* is derived from the Latin *poterium*, a drinking vessel, and therefore conveys no idea of the shape or substance of which it was made, but only of the use to which it was put. This is therefore the derivation of the French *potier* and the English *potter*, the ancient Greek name being also *κέραμος*.

The origin of pottery is lost in the mist of ages, partially baked utensils having been found together with the stone implements of pre-historic times, and it is exceedingly improbable that its invention sprang from

any one particular part of the globe or from any one particular race, as it is evident that it would fill a special want common to the whole human race. Pre-historic man must have observed the property of plastic clay to retain the water in the holes made by his own feet or by those of animals, and must have conceived the idea that articles might be shaped from it more suited to his wants than animals' skins or roughly hollowed wood or stone, nuts or gourds.

It is universally admitted that it is one of the most ancient of inventions, and probably was only preceded by that of the manufacture of arms, which would have been the first requirement of man for purposes of self-defence. It is more than probable that it was anterior to the discovery of fire, as sufficiently useful vessels can be made sun-baked, and are so made to this day in Egypt and India. Plato also points out that, as there is no necessity for the use of metals in the working of clay, its origin was of the very early ages. The two things from which we are able to prove the history of past ages are fossils and pottery, and in the latter are written the history of peoples and the progress and development of civilisation, and it is for this reason that men, whatever may be their studies or occupations, all take more or less interest in this art.

No branch of manufacture presents so ancient and intimate a connection between the useful and the beautiful as that of the potter, and both in its theory and practice it unites a combination of qualities unknown in any other expression of human skill. The shapes are endless in variety, and the beauty of the most successful pieces is matchless. Though difficult to discover its absolute origin, it is easier to decide to whom the honour of producing good qualities of articles is due, and in this we must assign to the Chinese and Egyptians equal place, as they both gave evidence of their skill at least 2,000 years B.C.

With the Greeks and Romans pottery was in high esteem, and often in the shape of vases formed part of the offerings to victorious generals. It seems to have been used rather for religious and decorative purposes than for the domestic uses to which we are accustomed to see it applied in daily life; and one of the most interesting purposes to which it was put was in connection with the dead, either in cinerary urns or to contain various articles placed in the tomb. It is probably to this more than to any other reason that we are indebted for so many specimens of the antique productions of different periods in existence to-day.

Attention should here be drawn to the wonderful action of heat on clay, which has enabled vessels, of so fragile a substance that it can easily be broken to pieces in the hands, to endure for thousands of years and to be hardly affected by atmospheric changes and direct contact with the damp soil; while coins and arms under similar conditions have deteriorated considerably from their original state. "Thus a piece of common pottery is more enduring than epitaphs in brass and effigies in bronze. Stone crumbles away, ink fades, and paper decays, but the earthen vase survives the changes of time and conveys its message from long past ages."

Although, as stated above, the chief uses for pottery in the Græco-Roman period were for decorative and religious purposes, it is indisputable that large quantities of pottery were also used in domestic life. Lamps, drinking cups, &c., exist in considerable quantities; but the chief reason for believing that the use was not generally domestic is that the vessels were not sufficiently fired, and were therefore too porous to heat liquids in or to be brought in contact with the greasy substances used in food. It is only in comparatively modern times that ware has been made to cook in, and on the old vases, &c., there are

designs of dishes for fruits, plates, and drinking horns, but no pieces of shapes suitable for culinary purposes.

There is no European pottery known of a body sufficiently close and firm to cease to be porous, or of lead glazed ware before the eleventh century.

The great advance in pottery was the invention and application of glaze to make it impermeable to liquids and foreign substances. It may be briefly stated that in the thirty or thirty-six centuries which we may say history acknowledges, twenty centuries passed in which, neither in Africa nor in Europe, was any glazed ware or any hard impermeable pottery made. On the contrary, in Asia, especially in China and Japan, from the earliest times a glazed and vitrified body like porcelain has been known.

More skill is required in the production of pottery than in the manufacture of articles from such materials as horn, wood, or stone, which require no after processes to render them serviceable, and though clay is more easily manipulated during the early stages of its manufacture it is more difficult to bring it to a satisfactory conclusion owing to the firing processes which it has to undergo. It is only in the last four hundred years at most that pottery has risen in Europe from its state of birth—coarsely and badly made—to the perfection of form and design and excellent workmanship that we see before us to-day, and year by year as it has improved in manufacture; apart from its application to all the daily wants of life, it becomes more intimately connected with industry, science, and art, supplying the manufacturer, chemist, electrician, agriculturist, and architect with new means, suitable to their varied wants—retorts, crucibles, insulators, drain-pipes, terra-cotta friezes, and an innumerable number of requirements daily increasing, and while giving on one hand, receiving on the other in exchange, new materials, chemicals and processes, new applications of machinery,

beautiful shapes and designs. It is thus in constant contact with all the different interests of daily life.

The ancient Britons manufactured baked clay ware, and Tylor remarks in his history of mankind that much of the early British ware was made in willow baskets which were destroyed during the firing, thus leaving a basket pattern on the surface. During the Roman period considerable quantities of articles both useful and ornamental were made on the banks of the Severn, Nen, and Medway; and England may be said to have eventually become the home of fine earthenware, though it cannot lay claim to the first production, as the *faience d'oiron* made in France at the end of Francis the First's and beginning of Henry the Second's reign, from 1520 to 1550, is true earthenware, most beautiful in design and execution, bearing upon it the impress of the genius of those who originated it, viz.: Hélène de Hangest, her librarian Jean Bernard, and her potter François Charpentier.

Up till about the year 1850 England held the markets of the world, owing to the great superiority of the quality of her products over those of her competitors, due to the genius and untiring zeal of such men as Cookworthy, Toft, Astbury, Elers, Dwight, Josiah Wedgwood, John Wall, Josiah Spode, Mason, the Davenports, and many others too numerous to mention; and the work they so ably began is being carried on and improved by the English potters of to-day in a manner worthy of their predecessors, and their best productions are still unrivalled in beauty and quality. But since that date the manufacturers on the Continent have advanced with enormous strides, and by the application of the science of the chemist and the mechanical engineer, coupled with the establishment of enormous factories managed on the most modern and economical principles (let us take as a type the group of potteries in the Rhenish provinces),

a competition has arisen which can only be combated by the greatest activity on the part of the English potter.

The general standard of quality required at the present day by modern markets is far higher than formerly and yet it must be produced and sold at a lower price. Owing to the opening up of new countries, and to a general higher standard of living, the demand continues to increase in spite of its modern competitors, tin and enamelled iron, which have so rapidly come to the front; but the increasing production of cheap china on the Continent cannot fail to exercise an adverse influence on the sales of earthenware, as for many purposes it is the more desirable production.

Mons. Faujas de St. Fond, the eminent French geologist, writing at the end of the eighteenth century on the subject of English earthenware, says: "Its excellent workmanship, its solidity, the advantage it possesses of sustaining the action of fire, its fine glaze impenetrable to acids, the beauty and convenience of its form and the cheapness of its price, have given rise to a commerce so active and so universal that, in travelling from Paris to Petersburg, from Amsterdam to the furthest part of Sweden, and from Dunkirk to the extremity of the South of France, one is served at every inn with English ware. Spain, Portugal, and Italy are supplied with it, and vessels are loaded with it for the East Indies, the West Indies, and the continent of America." What a different tale must be told at the end of the nineteenth century! Not only are most of these countries supplying their own wants by their own productions, but they are wresting many markets from the British manufacturer; nay, even successfully competing with him in his own home markets, and this not only by lower price but by superior quality in the general effect of their decoration and finish of their wares.

CHAPTER I.

DEFINITION OF EARTHENWARE AND GENERAL PRINCIPLES OF ITS MANUFACTURE.—FRENCH FAIENCE, GERMAN STEINGUT, ITALIAN TERRAGLIA, SPANISH LOZA.

EVERY ware made of clay, or of a mixture in which clay is the chief ingredient, and hardened by heat, may be regarded as a species of pottery, so that within this term anything from bricks to porcelain may be included, and of these various products the one selected for our special study is Earthenware.

The characteristics of fine earthenware are as follows: In biscuit (this is really a misnomer, as applied to fine earthenware, as the word signifies *twice baked*, whereas the term is applied to the firing of ware in its clay state, which is the first fire) it is fine but opaque; in texture and grain coarser than porcelain, the fracture porous but closer and more refractory than delft, neither vitreous nor translucent, moderately dense, sonorous when struck, hard, firm, and durable; it is covered with rich, rather soft fritted glaze, easily fusible, and containing lead or borax or both; it should be fine, clear, and vitreous, free from specks, transparent, to show the embellishment of the biscuit, and scarcely affected by acids, alkalis, or sudden alterations of temperature.

Fine earthenware always requires two fires, the first to bake the clay into the shape required—called the biscuit fire—the second to melt the coating of glaze over the piece and called the glost fire. The first fire is also necessary for two other reasons.

(1) If a piece of moist clay were glazed, the contraction between the vitreous glaze and the green or raw

clay would be so different that the glaze would probably crack or craze, even if the piece did not warp, by the action of the glaze permeating it, before the contraction had taken place, thus acting as a flux on the body.

(2) As the glaze materials are ground fine and held in suspension in water, the usual method for glazing is to immerse the piece in the liquid, and earthenware, when once fired, becomes sufficiently porous to suck up the glaze into which it is dipped, and thus an even coating is formed over it. Clay ware, unfired, would have no suction, and, in fact, dipping a raw clay piece into the liquid would, unless the greatest care were exercised, probably be sufficient to again reduce it to a simple mass of clay; added to this, pieces in this state would be very difficult to isolate from each other during firing owing to their softness.

The materials used in its manufacture may be divided into four classes :—

1. Plastic clays.
2. Glass-forming materials, used in the body or in the glaze.
3. Indifferent substances.
4. Colouring agents.

It is not intended to discuss every material that ever has or is likely to enter into the composition of the body or glaze, but only those which are generally considered most adapted for the purpose :

Class I.—China clay (kaolin), "ball" or "blue" clay.

Class II.—Cornish stone, carbonate or oxide of lead, tincal, borax, and boracic acid, felspar, whiting, carbonate of soda and pearl ash.

Class III.—Flint, quartz.

Class IV.—Colouring agents which are generally metallic oxides and metals.

From these four classes of materials it is desired to form a finished production whose characteristics have already been stated, but there are some other requirements for the purposes of manufacture which must also be taken into consideration.

A body mixture, in the moist state, must be sufficiently plastic to be easily workable into all the varied shapes required. It must be sufficiently infusible to prevent collapse in the ovens when fired at the heat necessary to produce hardness, yet must be sufficiently fusible to become dense and sonorous. It must have sufficient stability to resist excessive contraction, and should not be liable to become crooked; and it must be sufficiently clean and free from iron and other colouring matters to be white, or nearly so, after firing.

These qualities can only be obtained by a mixture; few, if any, clays combine all these requirements, therefore those they lack have to be artificially introduced, and the body becomes a mechanical mixture, and cannot be regarded or described as a chemical combination. It should also be remembered that the nature of the body will depend much on the heat to which it is submitted, and the same material may go through all the gradations from porous ware to glass at a continually increasing heat. The proportion of glass-forming ingredients in the mixture for earthenware bodies is purposely kept so low that the surface of the ware, after being exposed to the full heat of the biscuit oven, remains roughish and absorbent. For most decorative and nearly all domestic and sanitary purposes it is necessary to cover this surface with a smooth non-absorbent film; this result is practically gained by covering the surface of the ware with an extremely thin layer of glass, which is the glaze.

Glaze Mixture.—A perfect mixture must therefore form a vitrifiable compound which, when fired, shall be

transparent and shall neither injure nor be injured by any colours with which it may come in contact; in fact it should show up the embellishments of the biscuit and increase the brilliancy of the colours. It must be sufficiently hard to resist abrasion and have the property of expanding and contracting in nearly the same ratio as that of the body of the ware. This is of the utmost importance, as most substances expand with heat and when they cool contract, and if the contraction is different, the weaker substance will yield to the stronger. This is the great cause of crazing or cracking of the glaze. It must not be too fusible nor too hard, either of which is productive of crazing; but it must fuse at a temperature lower than that at which the ware has already been fired, and must, in fusing, spread equally over the ware without leaving any part uncovered.

Generally the less alumina there is in the biscuit the easier the adaptation of a satisfactory glaze.

The potter's object in regard to body and glaze is then threefold:—

1. To increase fusibility as he may desire (to make glazes).

2. To diminish fusibility on the contrary, to make a body that can resist getting out of shape and to make it stable.

3. To make glaze and body agree in order to avoid crazing, peeling, or blistering

CHAPTER II.

THE MATERIALS USED IN THE COMPOSITION OF THE BODY.

THE greater portion of the materials that enter into the composition of earthenware are natural products and are not artificially-produced chemicals, and it cannot be too much insisted upon that every material should be analysed and practically tested by putting it through all the processes it is intended to undergo before employing it in any quantity in the general manufacture of the ware. The old Greek philosopher said "Know thyself", no doubt a very desirable knowledge; but to this the potter may with advantage add "Know your materials". China clays from the same mines vary in plasticity, and in the amount of colouring matter they contain. Ball clays develop iron which, before firing, was quite invisible. China stones are of different density, and vary much in their vitrifying qualities. Flint may be insufficiently ground, or of an inferior quality.

Any one of these variations might cause enormous loss which, with a little foresight and a few trials, would have been absolutely avoided. Even in colours and chemicals there may be some foreign matter used in their preparation which, though innocuous as regards the manufacture of the material produced under ordinary circumstances, may combine with some special substance which is being used in the various mixtures of bodies and glazes and produce the most disastrous results.

There are two grand rules for the potter to observe: (1) Test every material, no matter whether clay, flint, stone, colour, glaze, oil, or what not, whether they have come from new sources or old ones—*always test.*

(2) Always be making some experiment, either in colours, bodies, glaze, moulds, or methods of manufacture; others have found out before you methods of improving or cheapening their productions. Why should not you also do something which, even if the result is neither what you required or expected, may lead you to some discovery that may be of use?

Very many of the greatest improvements in manufactures have arisen from experiments made for totally different objects. That the Egyptians or Romans were satisfied with certain methods of manufacture is no argument that these should hold good at the end of the nineteenth century. The important point in any alteration is to see that some definite improvement is made, or advantage gained by it. Mere change is not improvement, though nowadays it often passes for it.

It is not intended here to suggest reckless and expensive experiments, which take up both considerable time and money, but there are a hundred little things on a works which might be improved with a little thought, and a few simple experiments which may result in considerable saving. It should also be remembered that it is never safe to base opinions on the result of a single experiment, as there may, by chance, be a combination of circumstances, over which the experimenter has no control, which together cause the success of an experiment which otherwise would have failed. The heat in the oven, for example, may have gone to the exact degree required, and then have cooled, and this particular point of heat may never be exactly hit off again. A gas may be given off from some colour or material in proximity to the experiment, and form a combination with the material that is being tested, and chance will thus give a result which may never be obtained again. A hundred causes may affect a single experiment, therefore when the

result required has been obtained, before employing it in any large scale in the production, repeat the experiment and test it under the varying circumstances it will have to undergo in the manufacture in order to make sure that the result is reliable and can always be reproduced when required and is not merely a chance success due to some cause which cannot be accounted for.

Class I.—Plastic Clays.

Clay consists of a hydrated silicate of alumina in combination more or less with other substances, such as potash, soda, lime, or iron acting as fluxes on the silicate which otherwise would give no signs of vitrification. It is derived from the felspathic rocks which by their disintegration and decomposition have formed the clay. The reason why clay deposits are richer in alumina than the rocks from which they are formed is explained by the lightness of this substance which, being held in suspension in water a long time, was consequently carried farther, leaving the siliceous refuse, which is a heavy material, to settle on its way.

The foreign substances which are contained in the clays in their natural state modify their character according as one or more of these ingredients predominate. Iron, which exists in different states, is one of the most injurious substances contained in it, owing to its colouring properties, and clay to be used in fine earthenware must be almost entirely free from it. Lime may also cause difficulty, as although in its pure state it is infusible, when combined with alumina, silica, or alkaline silicates it is very fusible.

Its two chief ingredients are then silica or alumina. The former can be easily obtained in the form of sand,

flint, or quartz; but alumina is not found in a pure state, and only exists as a component part of clay.

Pure silica is refractory, but has a great affinity for alkaline matter with which it forms vitreous compounds. Too much silica in ware makes it brittle, and unable to stand sudden changes of temperature, the very qualities that alumina gives, and from it clays also derive their power of absorbing water and their plasticity; and yet, in its pure state, these are qualities that alumina does not possess, although it be finely ground and mixed with water. Nor can plasticity be obtained by mixing silica and alumina in the same proportions as they exist in clay. The means of obtaining plasticity has yet to be discovered, and plastic materials are relatively few. Pure clay is soft and more or less unctuous to the touch, and it may be converted into a doughy, tenacious, plastic paste, insoluble in water.

The most prominent physical properties of clay are its plasticity and its behaviour when exposed to heat. When slowly dried and exposed to a high temperature it shrinks considerably and splits into extremely hard masses, and will not fuse in the most powerful blast furnace in use in commerce. The stronger the heat, the more dense, hard, and sonorous the clay becomes, although generally remaining slightly porous. It dissolves with difficulty in borax, and forms a transparent glass at a high temperature. The ingredients which most affect the character of clay are sand, iron, lime, and magnesia, and its plasticity diminishes in the proportion to the amount of any of these non-plastic substances that it contains. The presence of sand affects it to the largest extent, magnesia less, and iron hardly at all.

By firing, the nature of clay is changed, and it becomes a firm, compact mass; and once rendered anhydrous by artificial heat, and the water previously held in chemical

combination removed, it can never regain plasticity by mechanical mixture with water. It is upon this property that its employment in the preparation of various classes of articles depends.

All clays contract in drying, and the shrinkage sometimes reaches 25 to 30 per cent in weight. The purest clays are the most infusible, and at the same time the most liable to fracture under the influence of heat. The iron in clays is often imperceptible before firing, owing to the presence of organic colouring matter; but heat destroys the organic matter, leaving revealed the pinkish or reddish iron stains. Most clays after extraction from the mines are "weathered", that is, exposed in the open for a considerable period; the sun disintegrates the mass of clay and the rain consolidates it again, which seems to some extent to diminish the contraction of the clay when it is afterwards mixed in the body, and also to facilitate manipulation. The longer it is weathered the better it is.

"Blue" or "Ball" clays are found in the lower tertiary clays of Devon and Dorsetshire, and are dug in the neighbourhood of Wareham and Teigngrace, and various other places. They are wonderfully plastic, and very free from iron. The former is shipped from Poole, and the latter from Teignmouth. The Poole clay is rather richer in alumina than that from Teignmouth, and should on that account be rather the superior; but in practical result the difference is not very apparent. The upper beds of the clay frequently contain a considerable amount of sand, and the best quality is not found till some depth has been reached. It is of a greyish blue colour, due to organic matter, and is unctuous and without grit. With a moderate heat it becomes white and remains absorbent, but when subjected to intense heat it is rendered so hard that it can hardly be

scratched with a knife, and it turns yellowish in colour, becoming non-absorbent. The free silica in the clay is in a state of very fine division.

ANALYSIS OF BLUE BALL CLAY AT A TEMPERATURE OF 212°, ACCORDING TO HIGGENBOTHAM (MUSPRAT, P. 790).

Silica	46·38
Alumina	38·04
Protoxide of Iron	1·04
Lime	1·20
Magnesia	(trace)
Water	13·44

ANOTHER ANALYSIS.

Silica	50·53
Alumina	39·74
Lime	·42
Magnesia	·23
Alkali	2·80
Iron	2·35
Water	12·20

The mines from which it is obtained are extensive, and the first operation is to remove the soil which lies on the top of the clay. The depth of this soil varies according to the locality, from 60 to 80 feet, and the clay itself is covered by a fine bed of sand. The clay is cut out in blocks, and carefully selected for shipment. The beds of clay vary from 3 to 6 feet in depth, and with the increased demand, both home and foreign, the industry has obtained considerable proportions.

One pint of ball clay slip at 24 oz. per pint, contains about 6½ oz. dry material. This weight is merely given as a guide, and would vary considerably with different ball clays.

Ball clay loses in drying before an ordinary open fire about 18 per cent in weight, and after firing in biscuit oven a further 12 per cent. Total 30 per cent between

the commercial article received and the clay when fired. This clay being almost always stored in the open, the quantity of water will vary much, the same clay in summer and winter varying much in the moisture it contains.

Its function in the mixture for the body is to give plasticity and facility in working. It is really the foundation of the body.

China Clay, or Kaolin, as it is called by the Chinese, is a white, or nearly white, earthy substance, though sometimes with a yellowish or pink tinge, easily pulverised. It is found in granite soils rich in felspar and contains a small amount of mica and porphyry. The felspar, its most important element, has lost by external influence the larger part of its alkali, and has become a kind of earth. It is found in China and Japan, and in France and Germany, and several other countries on the Continent, as also in America. The English supplies are chiefly drawn from St. Stephen's and St. Austell, in Cornwall, some also coming from Lee Moor, near Dartmouth, and a few other places.

China clays are prepared in different ways in different localities, according to the formation of the ground, but the fundamental principle is the same in all: that they must be thoroughly washed. To obtain this object the clay must be dissolved in large quantities of water, which it readily does. This result may be obtained naturally by running the water through the clay deposit itself, or artificially, by taking the clay from the deposit to the supply of water. The liquid is then run through trenches, or flumes, over settling pits, into which the heavy refuse, composed of mica and undecomposed felspar, sinks by its own weight to the bottom; the finer part, which is the china clay, overflows, and is carried on through sieves into large central tanks, where it accumulates. When

the tanks are filled, the washing process stops, and the fine clay is allowed to settle, and is removed in the slip or sludge state to wide shallow drying tanks, or it is dried artificially on kilns, or by steam pipes passing through the tanks, and in some places it is enclosed in perforated cylinders, which, revolving with great rapidity, extract the moisture. It remains drying till it is sufficiently stiff to be cut in squares and removed. It is sometimes considered necessary to sift sand over it to prevent any foreign substances coming in contact with it; but this has to be scraped off again when sufficiently dry to prepare it for shipment. In this state it becomes quite white, and, though not so plastic as ball clay, contains rather more alumina and less iron, which makes it more refractory.

Analysis of China Clay—Lord Playfair (Musprat, p. 789).

Silica	45·52
Alumina, with trace of oxide of iron	40·76
Lime	2·17
Potassia, with trace of Soda	1·90
Magnesia, Phosphoric traces, and Sulphuric Acid	(traces)
Water, with small quantity of organic matter	9·61

The commoner the clay the more plastic is it, and the better the quality the more careful must be its use, as an excess of it is liable to cause crazing.

One pint of china clay slip, at 26 ozs. to the pint, contains about 9 ozs. dry material.

The remarks on this subject in connection with ball clay apply with equal force to china clay.

China clay loses in drying before an ordinary open fire about $11\frac{1}{2}$ per cent in weight, and after firing in biscuit oven a further loss of 11 per cent on original weight, or a total loss of $22\frac{1}{2}$ per cent.

Its function in the mixture for the body is to make the body white and less liable to break under a heavy weight

or sudden changes of temperature. It also counteracts the want of plasticity in flint, the other whitening material.

Class II.—Glass-forming Materials.

China, or Cornish stone, is a granite in which the constituent felspar has been only partially decomposed, and retains sufficient alkaline silicate to render it fusible. Deposits of this stone intersect the granite hills in Cornwall beneath the mines from which china clay is obtained. Pegmatite, from which is obtained the chief source of china clay, is a form of the same rock, but in a more advanced stage of decomposition. It is quarried and shipped direct from the mines without further preparation there.

Analyses of Cornish Stone.

Silica	72·78	74·34
Alumina	17·22	18·46
Lime	1·40	—
Magnesia	0·31	0·24
Alkali	6·49	6·
Iron	traces	traces
Water	1·64	0·96

These would be average samples, but Cornish stone varies very much, especially in the amount of lime and alkali it contains.

As it can be easily fused it is found to be a useful and cheap flux and can be ground with greater facility than felspar.

It is ground very fine in mills with block stone runners, and it is of importance that the mill-stones should not contain iron, or, as they wear down, minute particles of the iron will be mixed with the ground china stone. Fuller particulars as to grinding are given in the Note on Flint, p. 21. No material requires more careful study than china stone, as it varies so much in the proportions

of the fusible material it contains, and therefore one sample will melt much more easily than another, or in technical language, is "softer". It varies in appearance greatly after grinding, and when mixed with water at the same weight per pint one sample will be quite thick and almost sludge, while the other will be comparatively speaking thin. When fired at ordinary biscuit heat by itself the surface becomes smeared and the interior slightly vitrified ; at intense heat the whole mass would melt. A certain amount of a similar stone comes from Jersey, but it is "soft" and has a slightly pinkish tinge which betrays the presence of rather more iron than is desirable.

One pint of china stone slip at 32 ozs. per pint contains about 19 ozs. dry material.

Cornish stone, that is to say, ground stone that has been dried for shipment, loses in drying before an ordinary open fire about 6 per cent, and after firing in the biscuit oven about 2 per cent of the original weight, or a total loss of 8 per cent.

Its function in the mixture for the body is to render the ware more compact and of a closer texture ; in fact being a flux to bind it together and to give it a good ring.

Class III.—"Indifferent Substances."

Flint contains moisture, an organic substance, and occasionally iron. Its chemical Formula is $Si\,O_2$. It is found in the upper strata of the chalk, and the best quality seems to come from Saint Valery en-Caux, near Dieppe, in France. Those nodules are preferred which are blueish black and which are free from iron and incrustation, as the lighter coloured ones do not calcine perfectly white, which indicates the presence of oxide of iron.

Silica is, after oxygen, the most widely distributed material on the earth's crust. In this particular form it is found in irregular shaped nodules weighing from a few ounces to several pounds. To facilitate the grinding of these masses they are first calcined in upright furnaces like ordinary lime-kilns, and during this process it is better that the material to be calcined should be kept apart from the combustible ; this is easily accomplished by having across the kiln a series of small fire-brick arches just sufficiently close to each other to prevent the nodules of flint slipping down into the fire-hole.

Though many manufacturers mix clean slack with the flints to insure complete calcination, the flint is thus rendered white and disintegrated and splits in all directions. It is then passed through an ordinary stamp mill or a stone crusher, by which means it is crushed sufficiently fine to be put on the mill to be ground. As was pointed out in connection with Cornish stone, great care must be observed in the selection of mill-stones which have neither colouring matter nor an excess of lime in them. The flint is ground in various sorts of mills, but the most usual is that with water and stone block runners. Attempts have been made to grind it dry and also to disintegrate it by means of steam jets, but the wet process is still the one in general use. It should be ground until it is of an impalpable fineness, and until it becomes a greyish white liquid, and should then be tested for fineness by passing through a fine silk lawn.

Many potters prefer doing their own grinding, as they are then sure of the materials they are using. The grinding of pottery materials has in England become a trade by itself, and in the Potteries district both flint and stone are sold by the millers in slop state at a weight of about 32 ozs. to the pint. But they are to be obtained dry for foreign requirements especially.

The proper grinding of both flint and stone, in fact of all materials which are required in a fine state of division in earthenware, is of the utmost importance, and upon it depends not only the facility of working and plasticity of the body, but the ultimate quality of the ware. Care should be taken that the runners in the mill do not always run in the same circle, or they will work grooves in the lower stones, and when new runners are substituted they will not work down into the grooves, and the result will be improperly ground material. Both runners and nether-stones will require constant attention and picking or roughing.

The mills should not be charged too heavily at first starting, nor should they be driven too fast or the material will not go under the stones, but be carried round with them. At most English factories the bottoms of the mills are paved with "Welsh Runners", which are replaced as they are worn down—the grinding stones being Derbyshire Chert. Only the water absolutely necessary for the grinding should be introduced, as an excess will increase the time occupied in grinding, and care must be taken that the material does not become too hot, which would indicate that the stones were being worn away excessively and foreign matter would thus be introduced into the material ground. Towards the finish, when the material is getting fine, care must be taken lest the stones get set, when there will be a break-down. Fineness can be tested by the expert by trying it between his teeth or nails, but the silk or wire lawn is always the safest and surest test. When flint is required extra carefully ground it will be as well to run it off into settling tubs, gradually drawing off the fine flint held in suspension and allowing the coarser to sink to the bottom. This latter can then be returned to the mills for regrinding.

Flint, when submitted to the heat of the oven, always burns white; it has a very small amount of contraction and its whiteness helps largely to correct yellowness in the ball clays.

One pint of flint at 32 ozs. to the pint contains about 20 $\frac{1}{8}$ ozs. dry material.

Flint, when sold ground in the dry state, loses by drying before an ordinary fire about $3\frac{1}{2}$ per cent, and after firing in biscuit oven the loss is hardly appreciable, therefore the total loss may be taken as $3\frac{1}{2}$ per cent.

Its function in the mixture for the body is to give whiteness and prevent excessive and unequal contraction.

CLASS IV.—"COLOURING AGENTS."

Cobalt stain, for improving the colour of the body. In whatever proportion the materials for the body may be mixed, the body, after firing, will have a yellowish tinge caused by the presence of oxide of iron in the clays which, however pure they may be, almost always contain traces of it combined in such a manner that it is impossible to free the body completely from it even after taking all possible precautions by passing it over magnets, etc.

To remedy this a small quantity of oxide of cobalt, technically called "stain", is added to the body when mixed. It is difficult to state the precise date at which oxide of cobalt first entered into the manufacture of glaze or ceramics. It was employed in the infancy of the art by the Chinese, Persians, Arabs, and Egyptians. Cobalt, being of a beautiful deep blue colour and being one of the few colours which retain their beauty at the highest temperature of ceramic ovens, acts by neutralising the yellow tinge of the oxide of iron, much in the same manner as the blue-bag used in laundries for whitening

linen, and gives the ware a pure white appearance; it is a grey metal, like silver when it is polished, and melts at about the same temperature as iron. It is not affected by air or water at ordinary temperatures, and is found chiefly in Hungary. It is not used commercially as a metal, and it is obtained in its purest form as a by-product of nickel.

Oxide of cobalt is generally obtained in two forms: the black oxide, and the prepared oxide of cobalt, which has already been calcined. It must be very pure, as the least trace of nickel in it would cause discoloration. The black oxide has about 10 per cent more colouring power than the prepared. It is usual to reduce the colouring power of cobalt by fluxing it in the following manner:—

5 lbs. black oxide.	or	10 lbs. cobalt { ½ black. ½ prepared.
5 ,, prepared oxide,		5 ,, flint.
5 ,, flint,		5 ,, stone.

This mixture should be calcined in a sagger in the hardest part of the biscuit oven. It is of blackish grey tint on entering the oven and becomes when fired to the required heat of a dark purplish tint. It must then be carefully ground in water and passed through a very fine lawn. It is of the utmost importance that the stain be properly ground to an impalpable fineness; should any insufficiently ground stain pass into the body, after firing, the ware will be seen to contain little blue specks.

It is generally used at about 14 ozs. to the liquid half pint. The quantity of stain to be used varies, of course, with the colour and quality of the ware that is to be produced. Ivory coloured or cream require little or none; white a considerable quantity. As it depends on

the colour of the clays, the only means of determining the quantity necessary is to make trials with varying quantities of stain in the body till, after firing, the tone of colour required has been obtained.

One pint of stain at 28 ozs. to the pint contains about 11 ozs. dry material.

Its function in the mixture of the body is to counteract the oxide of iron and make the ware white.

CHAPTER III.

THE MIXTURE OF THE MATERIALS FOR THE BODY.

IT will be as well to restate our requirements in the body.

It must be sufficiently plastic to be easily workable. It must be sufficiently infusible to prevent collapse in the ovens, but sufficiently fusible to become dense and sonorous. It must have sufficient stability to resist excessive contraction and must not become crooked. It must be sufficiently free from colouring matters to become clean and white after firing.

To obtain these results the already mentioned materials have been selected for their various characteristics, which it will be as well to restate also.

Ball Clay. As the foundation and to give plasticity.

Flint. To give whiteness and prevent excessive contraction.

China Clay. Also to give whiteness and make the body less likely to break under a heavy weight or sudden changes of temperature. To counteract the want of plasticity in flint.

Cornish Stone. To render the ware more compact, closer in texture, to bind it together and to give it a good ring.

Oxide of Cobalt. To improve the colour of the finished article.

Water must here be mentioned as although it only

forms part of the composition of the ware in some insufficiently fired piece, and must therefore be considered non-existent in a finished piece of fine earthenware, yet it must be used to mix the materials to give them the necessary softness for obtaining the plasticity required in the manufacture. A knowledge of the analysis of the water used is also necessary, as it may contain substances which would combine with clays in an unexpected manner, such as magnesia, soda, lime, &c.

These materials have then to be mixed in such a manner as to combine artificially the alumina and silica in other and different proportions to that in which they already exist in order to form other and better wares than would result from these materials in their present state, even if ware could be made from them without a mixture, and to remove any existing matters from them that could be detrimental to that object.

The quantities of each material used in the mixture vary considerably in different manufactories, and it is evident they must so vary according as the physical or chemical natures of raw materials vary, and therefore recipes and even analysis of wares are of very little practical use, and the only object for which they can serve is to put the experienced and educated manufacturer in the way of making experiments and trials which may lead him to obtain the object he has in view. The annexed formulæ are given merely to explain the system of manufacture; and because they have given satisfactory results in these proportions it does not follow that the result would be equally satisfactory with another set of materials and under other and different conditions.

The only possible way of obtaining a mixture suitable to one's requirements is to experiment with the materials under the same conditions they will have to undergo in the commercial manufacture.

BODY FORMULÆ IN WET INCHES.

		Good.	Medium.	Common.
Ball Clay,	at 24 ozs. per pint . .	10	11	15
China Clay,	,, 26 ozs. ,, . .	8	9	8
Flint,	,, 32 ozs. ,, . .	5	4½	4
Stone,	,, 32 ozs. ,, . .	2½	2½	2
Stain,	,, 25 or 28 ozs. per pint.			None

(In varying proportions with the colour that is required.)

There are two modes of mixing · the "dry" and the "wet". In the former the materials are weighed out in their proper proportions dry, and the advantage of this method is that all the materials can be blunged or mixed up in one "blunger", as the tanks in which the water is mixed with the materials are called ; and therefore less room and less motive power are required, and it may be looked upon as the cheaper method. But it has this great disadvantage. The materials absorb water in a different degree. Flints vary little ; stone rather more ; and clays a very great deal ; and if some of the clays are weathering in the open air, which is almost always the case with ball clays, the quantity of moisture contained in them would be different from day to day and the real quantity of dry clay in each pound would be a continually varying amount. Apart from this, in weighing out large quantities, which is done in baskets or boxes, it is exceedingly easy to make a mistake in counting the number of boxes or baskets as they are being weighed ; and a mistake in any material of one measure would upset the whole balance of the mixture.

In the wet system each material is blunged up till the "slip", as the mixture of material with water is called, is of a specified weight per pint, that is to say, either water or material has to be added till the required weight is obtained. For this purpose it is necessary to keep in the "slip house", scales and a pint pot, and before making a mixture every material must be weighed to see

that its weight is exactly right. The usual weights for the materials per pint are, for ball clay 24 ozs., china clay 26 ozs., flint 32 ozs., and stone 32 ozs. Stain varies; but anything from 25 ozs. to 28 ozs. would be a suitable weight. As these are the net weights, a counterweight the exact equivalent of the pint pot is required in the other side of the scale. After each material is weighed the pint pot must be washed before proceeding to weigh the next material. The weights of the various materials are so different that, were this not done, a small quantity of the previous material weighed would be left in the bottom or stick to the side of the pot, and thus the true weight of the later material would not be ascertained. It is therefore necessary to see that the materials are weighed exactly, as it will at once be perceived that a difference, though small in a pint pot, would be very large when run into the mixing ark or tank.

In former days, and in some manufactories to-day, where the newest appliances have not yet been introduced, the materials are mixed with the water in open tanks and blunged up by hand with long wooden implements like hoes or rakes; but in factories where machinery has been introduced the materials are mixed in octagonal iron blungers, covered at the top with wooden covers in which there are doors for the admission of the material, while a pipe or trough is connected with them for introducing the water.

In the Staffordshire Potteries, flint and stone are sold by the various millers in the slip state at about 32 ozs. to the pint, so that the materials to be blunged up are the ball clay and the china clay; but to the two blungers necessary for these must be added a third for the "scraps", as the broken pieces of clay ware, clay shavings from the turner's and bits of clay cut off in the various processes of manufacture are called, of which there is

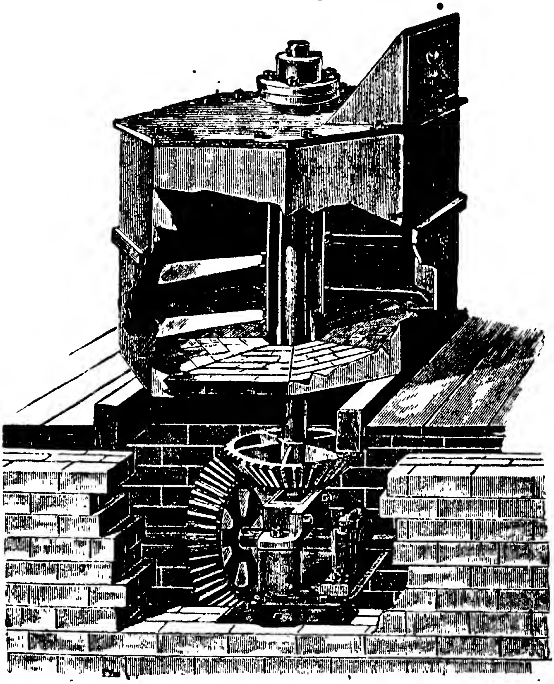
always a proportion added to each mixing, as, having already once been worked up, it seems to give more consistency and facility in working, to the body.

These remarks apply only to scraps in their moist state, as should they be allowed to dry hard the reverse will be the case, and a body remade from dry scraps only will work "short", that is, would be wanting in plasticity. Being of the same component parts as the mixture, scraps do not much affect the composition of the body, whether they enter in a large or small quantity, and though not a matter of great importance, they are blunged up to about 26 ozs. per pint. In manufactories where the flint and stone are bought in the dry state, these would also require blunging, which would necessitate in all five blungers: ball clay, china clay, flint, stone, and scraps, unless a dry mixing were used, which would necessitate the weighing out of each material separately, though they could afterwards be mixed in one blunger.

The weights per pint of the different materials which are here mentioned have not been assigned merely arbitrarily; but from long experience it has been found that at these weights the materials are generally best held in suspension in the water and mix together easily. If too much water were added, the materials being in themselves of different specific gravities would be inclined to keep apart and not so readily mix. It would also take longer to pass through the presses, and thus cause greater destruction to the press cloths.

The modern blungers, as we have said, are octagonal iron tanks, which with advantage may be paved, and are arranged with shafting underneath them, connected with the motor-power. To this shafting are attached by cog-wheels the shafts or spindles which pass through the bottom of the blungers and rise a little above the top of them. On these shafts the hollow cylindrical tubes which

carry the blades necessary to churn up the material are keyed and secured from slipping with a set pin. The blades are set at an angle on the principle of the



BLUNGER.

Archimedean screw, and the material is, therefore, being continually raised to the top of the blunger, where iron splash-boards with holes in them are bolted to the sides,

and the slip is dashed down again to the bottom ; and this process is continued till the material is thoroughly mixed with the water. It is of importance to see that the set pin is well screwed up, or the cylinder may in working slip down the shaft, which at least would result in the breaking of the blades or the cylinder, and might cause a serious breakdown.

If the flint is blunged, it is as well to churn up only the quantity required for the mixing, so that when the flint is run off only a small quantity is left in the blunger. Flint has a nasty way of setting at the bottom very hard, and if there is much flint in the blunger, and the mixing blades get buried in it, it is almost impossible to move them, and if the engine or motor power were started suddenly something must give, and if it is not the blades it will be some of the cogs out of the wheels, or it may cause damage to the shafting itself. Therefore the blungers should always be started with care, and should not be overloaded with materials before starting.

It is as well to have the blungers erected so that some of them will run one way and some the other ; this is of no importance as long as the cylinders carrying the blades have been cast to run the way required, and it certainly takes considerable strain off the shafting. Blungers are sometimes on a floor above the mixing ark, but the general arrangement, on account of the quantity of material required to load them, is to place them on the ground floor, though about one foot above the flooring, the mixing arks being excavated and built below the floor. The simplest method for running the materials into the mixing ark is to have a trough carried along the front of the blungers, having their valves for drawing off the material fitted in it. The trough should slope slightly towards the point where the exit to the mixing ark is made, and there should be boards fitted in the trough in

grooves between each blunger, which can be put in and out as may be required for the running off of the different materials. The exit should be in the bottom of the trough, and should be covered with a coarse lawn, or rather sieve, to catch any improperly blunged lumps or foreign matters which afterwards might get into the valves or clacks of the pumps.

We may now suppose that all the different materials are blunged up, and have been weighed and found correct. They have now to be run into the mixing ark, which is below the floor-level. These arks are made either bricked and cemented over, or built with nicely faced bricks and cement; and they have fixed in the centre large iron fans attached to a spindle, and to a shafting running overhead, and can be thrown in or out of gear as required. Arks built of an octagonal shape are the best, as it aids the mixing of the materials; whereas, if round, the fans are likely to carry the materials round and round, and they do not get such a good mixing up.

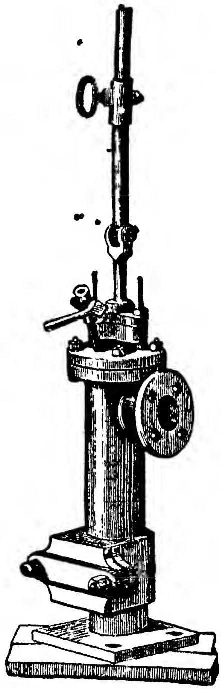
There are many ways of measuring the proportions of the materials into the ark; in some cases the number of inches required of each material is marked on the side of the ark itself, in others it is registered on the wall of the slip-house by a weight attached to a float in the ark. But, perhaps the simplest and most accurate is an ordinary deal lath about an inch square, planed smooth, and with nails driven in at right-angles at exactly the height in inches required for each material. The lath is placed upright in the ark, and the materials are run in one by one, and each up to its nail driven into the lath or "mixing staff". If the light is not good, a small lamp or lantern can be lowered into the ark, so that the nails can be easily seen, and the flow of material cut off as soon as the liquid rises to the nail. It really should be cut off just before it reaches the nail, as a little material will be

left in the trough, which must be carefully scraped down into the mixing ark before the next material is drawn off. This applies especially to flint and stone; and with reasonable care mistakes are impossible. We therefore consider wet mixing is the most accurate, and by far the safer of the two methods. It is usual to run in ball clay first, then china clay, flint, and lastly, stone. This order rather assists the mixing, as the two heavier materials are put in last, and would, therefore, be inclined rather to fall through the others.

Our mixing is not yet quite finished, as we have to add the stain, which is the last operation. After the stain has been carefully ground and lawned, the quantity decided on for the mixing is carefully weighed and passed through another lawn into the mixing ark, and the vessel containing the stain is washed with more water, and that water passed also through the lawn into the mixing, so that none of the stain is left behind. Care should be taken that the stain does not dry or cake on the side of the vessel, as, if any little grains of dry stain go into the mixing, it is sure to show up afterwards in little blue specks on the ware; in fact, causing the same imperfection as if the stain had been insufficiently ground.

The mixing being finished, the fans are started, and the clay slip from the scrap blunger run in. Should a larger amount of scraps than usual be used, the mixing may require a slight additional quantity of stain, as if a mixing of scraps alone were made, it would probably be found that, after firing, it would not be quite such a good colour as fresh made body, owing, no doubt, to the scraps getting dirty in working. When all the materials have been sufficiently mixed, the slip is pumped by an ordinary pump, driven from a shafting into the lawns. These lawns are either silk or wire, and are

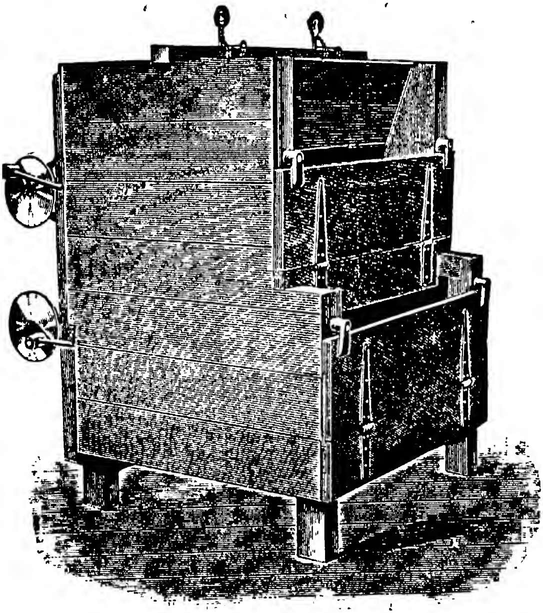
fixed on ash lawn rims. They are now usually arranged in a lawn box, one above the other, in two or three tiers, two lawns in each tier. A hook attached to an eccentric is fixed to each lawn, which pulls them backwards and forwards over glass slides, which offer little resistance to their movements, the motive power being obtained by belts from a shafting. The stream of slip is regulated by two valves at the top, and the quantity of slip that passes must be arranged according to the class of body and the fineness of the lawns. The numbers of the silk lawns used are 14's and 16's, the coarsest being above, and the finest below. 18's are sometimes used, but it would take considerably longer to pass a body through so fine a lawn.



SLIP PUMP.

There are gauges made for testing lawns in the form of a square aperture with a magnifying glass fixed above it, and by placing this on a lawn the number of threads can be counted in this given space, and compared with other lawns. It may be taken as a general rule that wire lawn of a given number of threads will sieve finer than a silk lawn of the same number, probably because the silk gives a little, and allows particles to go

through, which the wire lawns, being more rigid, would not allow to pass. Wire lawns last longer, and should be more economical, though their first cost is rather higher. The lawns have to be washed from time to time, as the sieving



TWO-TIER LAWN BOX OR SIFTER.

is progressing, to get rid of the dirt which they extract from the clay, and, of course, the finer the lawns the more dirt will be extracted from the slip, and, therefore, the finer lawns that can be used, taking into due regard

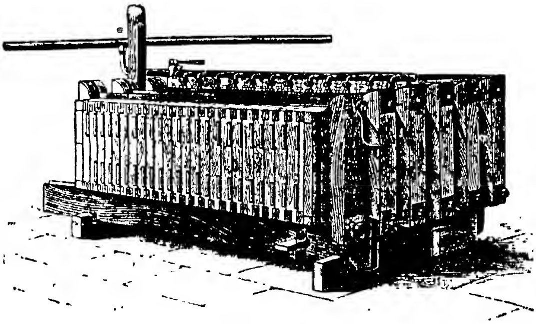
the time it requires to pass through, the better for the body, and apart from obtaining a cleaner body, there is no better method of mixing than by passing through lawns and by the method here described the slip passes through two or three of them. It is well to bear in mind that lawns, though showing the maximum size of the particles passed through, do not show the minimum. From these lawns it passes down to the "finished" ark, which is of similar construction to the mixing pot, or ark, also with revolving fans in it.

In passing down, the slip is carried through a box in which are placed a quantity of electric or ordinary horse-shoe magnets, the more the better, and as the slip passes through it must at some period of its course come in contact with the poles of one of the magnets, and any little particles of iron that are free in the slip, either originating in the materials themselves or picked up in passing through the machinery, will stick to the magnets, and on carefully washing the latter in water and holding them up to the light the iron can be seen sticking to them. Magnets may also be attached to the fans in the finished ark if considered necessary.

It is of great importance that all the iron possible should be extracted from the slip as, even should the iron not cause little brown spots or specks in the ware, it is sure to make it of a yellowish tinge. It is, therefore, necessary to keep the magnets well cleaned and up to strength. If horseshoe magnets, they will want constantly strengthening by a king magnet, and, as by continual cleaning the marks of the different poles are obliterated, it is well to have the mark of the north pole deeply filed in, so as to avoid making mistakes as to the poles when remagnetising with the king. If magnets have to be remagnetised, which they will require about once a week or so to keep them up to the mark,

place two magnets flat on a board or in a frame with their contrary poles touching each other. Then place the north-pole of the king magnet next to what is the south-pole of one of the magnets to be strengthened, and move the king round and round over the magnets, always in the same direction, till they have recovered sufficient force.

In the majority of potteries iron pipes and pumps are in use, but iron is such a fruitful source of discoloration



FILTER PRESS.

in ware that it is better, although the first cost is much heavier, to have enamelled or copper pipes and gunmetal pumps and connections, &c.

The manufacture of the body in the slip state is now complete, but it is in far too liquid a form to be of any use in making ware, and so sufficient water must be extracted to leave the clay in the doughy, plastic mass necessary for working.

There are three ordinary ways of doing this. The

first is by pouring the slip into large plaster moulds, which gradually absorb the moisture from the clay. This is costly, on account of the quantity of moulds required, and slow, in fact quite unsuited to the production of clay on a large scale.

The second method is by heat: a large shallow tank is made, sometimes 80 to 100 feet long, the bottom being made of fire-clay quarries or tiles, and having flues running underneath it. The chimney is at one end, and the fire-hole at the other: and as the heat increases the humidity in the clay is driven off. This method is still practised in some works, but the disadvantage of it is the expense for fuel, and the fact that the kiln can only be filled once, and, therefore, the clay made once in a day. It is then also rather a slow method of production, and, no doubt, will gradually die out before the modern system of the filter press.

This is the invention of Messrs Needham and Kyte. The press is formed of a series of wooden trays. The frame consists of a frame of teak, oak, or other hard wood, and a body of deal grooved and sunk half an inch below the frame on each side, so that when one tray is placed on edge against another, though the frames, which are about $2\frac{1}{2}$ inches wide, fit closely together, there is a space left between the bodies of the two trays, which forms a chamber about 1 inch deep. The grooved blocks should have a space of $\frac{1}{4}$ inch left between them in every 6 inches, to allow for the swelling of the wood when wet, and also to allow the water exuding from the cloths to escape. Each tray measures about 2 ft. 1 in. by 6 ft. 5 in. by $3\frac{3}{4}$ in. The framework of the two end trays is much stronger than the others, and on the outside of them thick pieces of hard wood called knees are bolted on; these extend a little above and below the trays, and have a deep notch cut in them both above and below;

these notches are usually faced with iron, and the iron rods which pass from back to front of the press for screwing it tightly together, fit into them.

The usual number of chambers in the presses is twenty-four, though smaller ones are used if only small quantities of clay are required. A twenty-four chamber press, when screwed up together, measures about 7 ft. 6 in. by 6 ft. 6 in. by 2 ft., and has six iron rods above and six below to screw it up. For convenience this rectangular block of trays is placed on a stand formed by two beams held together by cross pieces, raising the press about 15 in. from the floor. When the press is nearly "up" the pressure sometimes is so great that the nuts have been known to strip the screw off the rods, and fly off. The worms should, therefore, be cut very deep, and it is as well to have a sheet-iron shield to hang over the front of the press if the workmen have to be continually passing in front of it.

Before the trays forming the press are put up and screwed together, the press cloths, which are the means by which the clay is to be obtained, are carefully arranged in them. These cloths are made of the best cotton material, strongly and evenly woven to resist pressure, and are often prepared with chemicals before using, to prevent rotting, as they are specially liable to a sort of vegetable mouldy growth which soon destroys them. The cloths thus dressed certainly last longer than undressed ones, and a dressing properly applied, which does not stop up the interstices of the cloth, appears to have no undesirable effect. Cloths should be numbered and dated and a book should be kept in which the dates on which they are put into use is noted as well as the dates on which cloths are repaired. By this means the quality and their duration in use can be ascertained and carelessness and waste can be checked.

Unless carefully looked after, cloths will form a very heavy item in slip house accounts. A press cloth with proper treatment should last about four months or more. The cloths are placed on the trays and doubled over evenly; when doubled they should overlap the bottom of the trays about 9 inches, and the side about 6 or 8 inches. These overlapping edges are carefully folded up till they lie perfectly flat in the chamber inside the frame of the tray, thus really forming a bag. Care must be taken that the cloth does not get between the frames, as, when the pressure is applied, it will be cut and the clay will escape.

It is by far the best to have two cloths, the outer one next the woodwork being much coarser, generally of Hessian, and merely to protect the inner cotton cloth. They are put in the tray together and folded at the same time. Near the centre, but a little to the right or left of it, in alternate trays, and at the point where the cloth is first doubled, a gun-metal tube is attached to the cloth, and passes through the frame of the trays, and it is by this tube that the clay is introduced into the bags which the cloths folded as described, now form. The metal tube really passes between the frames of two trays, a sufficient quantity of wood being cut away to admit of its passage between them. The tube is attached to the cloth by a nut and it is as well to have a couple of flannel washers each side of the cloth to prevent the tube nut fraying it.

A gun-metal or sometimes galvanised iron stand-pipe is placed across the press from back to front communicating with the supply-pipe from the press pumps. To the stand-pipe are attached gun-metal nozzles which are at the requisite distance on each side of it to be connected to the metal tubes rising through the tray frames from the bags or cloths. Each nozzle has a tap to it, so that any one chamber can be shut off without interfering with

the charging of the others. This is necessary in the case of a cloth bursting.

There are several forms of nozzles, but the best one is made in the form of an ordinary tap and is far stronger and less likely to get out of order than the zig-zag shaped one that has been generally used. The nozzle is joined to the metal tube by a grooved attachment requiring only half a turn with the spanner to connect it. The nozzles have a certain amount of play where they join the stand-pipe, so that they may come exactly over the metal tubes in the trays. When a press is being taken down, after the nozzles have been detached, it is necessary to lift up the stand-pipe in order to take out the trays; it is therefore as well to have an iron hook from the roof at the front of the press and about two feet above it; the end of the stand-pipe can then be raised and the hook attached to it. For this reason the stand-pipe must have a slight amount of play where it joins the supply-pipe. The height it has to be raised is only what is necessary just to clear the tube in the back tray, so the movement is really very small.

The principle of the press is filtration by pressure; that is to say, the clay slip is pumped by force pumps through the stand-pipe into the cloths formed like bags in the chambers of the press. The bags retain the clay, as the cloth is too fine to allow it to pass; but the water filters through, coming out perfectly limpid, and leaving all the material it before held in suspension in the cloths. In some other manufactures the presses are used in exactly the opposite manner for filtering moist substances; the refuse remaining in the cloths and the transparent liquid flowing from the press is collected. When no more water will trickle through, and it is clear no further material can be driven in, the pumps are

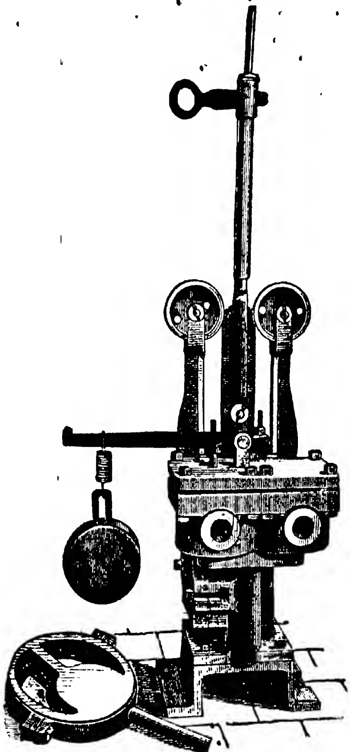
stopped, the press is disconnected, taken down, the cloths unfolded, and the clay taken out.

The clay is formed in the cloths like a corrugated mat about $\frac{3}{4}$ of an inch thick, 5 ft. 3 in. long and 1 ft. 7 in. wide. The cloth comes easily away from the clay, but it is as well to have a couple of thickish copper scrapers in case there is any wet clay which sticks to the cloth. The clay mat is rolled up and carried away, and the cloths are at once refolded to commence the operation again. Cloths must be washed regularly, as the pores in the cloth after a time get stopped up, and the water not passing freely causes them to burst with the pressure; and presses should be kept in thorough order.

Care is necessary in folding the cloths that they fit right up to the edges of the trays; if folded too short or too narrow the cloth has to take the pressure instead of the press, and the cloth is sure to burst. Cloths should be folded in the press *wet*, as they contract when wet, and if folded in the press dry, though they apparently fit exactly, yet when the wet slip is introduced they contract and a burst is probable. Bursting cloths are a source of much annoyance, and though it may not mean an absolute loss of clay, it is at any rate a loss of time, and it also means that the tap of the nozzle, from which the chamber containing the burst cloth is fed, must be turned off: and, as the other chambers get filled, there is not the same amount of material in the chamber with the burst cloth, and the pressure is not divided equally over the whole press, and this is a fruitful source of strained and warped presses.

To avoid the inconvenience of warped trays iron presses have been introduced, but they have not met with general favour, no doubt owing to the fear of discoloration from rust. The clay then has to be pumped from the finished ark into the presses, through the stand-pipe and nozzles,

by specially constructed force pumps working up to a high pressure, driven from the shafting; and, as much

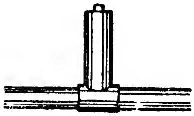


PRESS PUMP.

force is required, the eccentric on the shafting by which the pump is worked should be placed as near one of the

supports carrying the shafting as possible, and it is an additional security to have an inch iron rod bolted to the support, and also to the casting to which the pump is fixed, as it counteracts any tendency the pump may have to force up the shafting, and is conducive to smooth working by giving more rigidity and strength. Each pump is provided with a safety pressure valve which only opens when the press is full and cannot contain any more solid clay. Without this valve, which opens and lets the clay back to the ark, either the pipes or the connections would burst.

The supply pipe should have a short piece of pipe about 3 ft. high, closed at the end, fitted uprightly to a T-joint, near each press to act as an air cushion and relieve pressure.

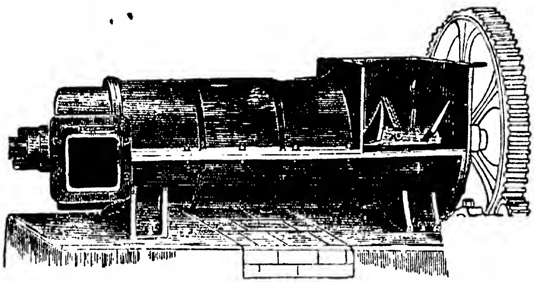


The valves, washers, and rings of press pumps require careful attention from time to time, as the slip, continually working through at high pressure, cuts them up considerably and unless the pumps are in good condition and well fettled the presses take much longer to fill. Each press takes about an hour and a quarter to fill, though the time will vary with the composition of the body: those containing more flint will come up quicker than those containing a large proportion of ball clay, as in the former case there is more dry material per pint of liquid slip pumped into the press. A twenty-four chamber press will produce each time it is charged about 18 cwt. of clay ready for the pug mill, though the weight will vary according to the class of body manufactured. The depth of the trays of presses also varies slightly and this would of course greatly affect the quantity produced.

The floor on which the presses stand should be sloped

slightly back towards a drain leading to a tank, so that the water dripping from the presses can be collected for use again if required. A pail or two should always be kept handy in case of a burst cloth to catch the escaping slip, which can at once be returned to the finished ark to be pumped through again. The last operation to be carried out in preparing the clay for the workmen is now to be described.

The clay coming from the presses (or slip-kiln) may not all be exactly equally moist, and in order to



PUG MILL.

give it consistency and homogeneity, the old system was to cut off a piece of clay with a wire and dash it down on another piece placed on a specially prepared block, faced with plaster, and this operation, called "wedging", was repeated till the clay was thoroughly incorporated and of the same density and moisture. This operation is now carried out at a great saving of labour, by the pug-mill, which is not unlike in action a large sausage machine. It is cylindrical in form and made of several castings, so that the top part can be unbolted in case

it should be necessary to clean it out An axle runs through it from end to end, and to it are attached blades of iron set at such an angle that, while cutting the clay, they are continually pressing it forward.

Thus the pug is fed from the top to one end, and the clay is cut up and squeezed out in a solid block like a sausage, about 6 in. × 4 in., at the other, and it is far better prepared and more equal than ever it could be if "wedged" by hand. It is as well to have at the exit of the pug a small wooden stand made with four or five little wooden rollers on it on which the clay block can rest in coming out. The clay is then cut off with a piece of brass wire in lengths as required, and is ready for the workman.

Cleanliness and tidiness are absolutely essential in all parts of a pottery, but in no place should they be more insisted upon than in the slip-house. No one except those employed in it should be allowed there, as the more coming and going the more dirt will be brought in. The clay should be cut off from the pug and wheeled out to the shops by one man, and distributed by him, or should be put in a place where each man can help himself. But potters should not be allowed to fetch their clay from the slip-house.

The slip-maker should never be without a sponge in his hand. In the many operations he has to carry out there must be slip-splashes on his blunger-doors, troughs, utensils, &c. While wet they can be removed with the greatest ease; but if allowed to dry, it would take a considerable amount of work, and would then hardly be done in so satisfactory a manner.

It is better that all machinery, utensils, &c., should be kept well painted, to avoid the danger of iron in the body, and if painted in bright red and green any white splash of clay is at once seen, and can be cleaned off.

manner one body can be compared with another. The fracture must be noticed carefully, as an air bubble or grain of material is sufficient sometimes to cause a break which otherwise would not have occurred, and the deduction from the experiment would be misleading. Equality in moisture and fineness is also necessary for obtaining reliable results. When new materials are used, or an alteration in the mixing is made, it is as well to have all the ware produced from that particular mixture especially marked. and a note should be taken of it for future reference; so that should there be any defect its origin may be traced.

The water from the presses should not be allowed to run away, as, apart from its cost, there is always a certain amount of clay from burst cloths, leakages, &c., mixed with it; it should therefore be pumped back to make other mixings, especially in the scrap blunger. If, however, space admits, it is far better to have one or two settling tanks, into which it may be run, and as the clay settles down the water may be drawn off and used again, or else it may be run into the drains without fear of gradually choking them up. It is extraordinary the amount of clay that may be saved in this way in the course of a year, and should this clay not be considered sufficiently good to be remixed with the best body, it will always serve for common body or for stilt clay. It is such small economies as these that require attention, as, though the daily loss of clay may seem small, at the end of the year it will mount up to many tons.

Body slip is about 26 ozs. to the pint, which, if thoroughly dried, would give about $9\frac{1}{2}$ ozs. per pint of dry material.

CHAPTER IV.

THE MATERIALS AND THEIR PREPARATION FOR THE GLAZE.

ALTHOUGH there are many processes to be gone through before the glaze is required it will perhaps be better to discuss it before proceeding to the manufacture of pieces, as many of the materials used in the preparation of the body also form part of the glaze.

Let us again briefly define the requirements in glaze.

It must be a vitrifiable substance which, when fired, shall be transparent, and neither injure nor be injured by any colours with which it may come in contact, and must unite thoroughly with the body. It must be sufficiently hard to resist abrasion and should not be easily affected by acids, and have the property of expanding in nearly the same ratio as the body; it must fuse at a lower temperature than that at which the biscuit has already been fired, and must in fusing spread equally all over the article to be glazed. The glaze, besides adding cleanliness, gives an appearance which pottery without it could never obtain, and it makes many classes of decoration possible, which otherwise could not be attempted. No mention is made of raw glazes, as they are both unsuited to a high-class article, and unwholesome both in their use and manufacture. There are, broadly speaking, three classes of glazes: transparent, opaque, and coloured. The two latter are generally used either to cover a body that is disagreeable in colour or to give decorative effects, and the transparent glaze is the only one that need be discussed in connection with fine earthenware. The foundations of the glaze are in principle similar to those of the body.

Silica in the form of sand, flint and china clay, which are the hard materials, and which are fused into glass by the aid of tincal, boracic acid, borax, lead, soda, china stone, and whiting, &c.

Vitreous matters, to have a glassy appearance, must be raised to at least a red heat. Pure lead glazes fuse at about this temperature, but they are soft, can be scratched with a knife, and are easily attacked by acids. Other glazes require a much higher temperature to fuse them, and are much less influenced by acids, and are far harder.

When substances, either simple or complex, are submitted to heat, there becomes at once apparent a wide difference in their fusing properties; some become liquid with facility; others must be submitted to white heat; others, again, only fuse at the very highest temperatures used in commerce, and there are some that even, in those circumstances, do not appear to undergo any alteration. The contraction, as has already been pointed out, must be in the same ratio as the body of the ware, in order to avoid crazing, peeling, and other defects. As it will be necessary to refer to the properties of the various materials employed, it will be as well to state what is meant by infusibility. It is probable that any material would fuse or volatilise if sufficiently intense heat could be obtained. But for ordinary purposes any material which resists unchanged a heat of 1800 C., or about 3270° F., may be considered infusible. A glaze must not be too thin, or the ware will have a rough and poor appearance, and it must also receive a suitable fire, as defects in glaze are as often due to the firing as to the combination of the materials. If the glaze is too hard, it will not flow well over the whole piece, and will leave little bare points uncovered, and unless subjected to very great heat, the ware will have a dull appearance, and is not "up", as it is called.

If the glaze is too soft, it will run down the piece and collect in drops on the edges, and it will flow the colours, and give the patterns an indefinite smudgy appearance; but too much fire, or too heavy dipping, might cause similar results.

Crazing, which is the most grave defect earthenware can have, is generally caused by the glaze occupying less volume in its fired state, and its consequent inability to envelope and completely cover the body of the ware underneath, and, being unable to stretch, it cracks in all directions. Pieces with this defect admit through the cracks any moist or greasy substance which, gradually decaying in the porous body, turns it yellowish brown, and gives the piece an unpleasant smell, and makes it thoroughly unwholesome. Gradually the piece loses all ring and, when struck, sounds like a piece of board. If continued in use, it will eventually fall to pieces.

This defect, among the Chinese, was in certain ornamental pieces looked upon as a beauty, but it is probable that they arranged their body and glaze to obtain this effect, and that it was not a mere matter of chance.

But, much as this "crackle" ware is appreciated in ornamental pieces by the collector, for every-day use pieces with this defect would be rightly looked upon, both by dealer and consumer, with anything but approval. Glazes that have a thin appearance after firing, are less liable to craze than thicker-looking ones, as they can, in the process of firing, should they not be properly balanced, absorb sufficient silex or alumina from the ware, and thus correct to some extent the balance by annexing some of the material lacking in their own composition. This is no argument in favour of thin glazes; the potter's object is to obtain either thin or thick glazes as he may require them, and to make them agree with the bodies he is employing.

The materials used most generally in earthenware glazes are: flint and china clay, which may be called the dry materials; Cornish stone, tincal, boracic acid, borax, carbonate or oxide of lead, carbonate of soda (soda ash), carbonate of potash (pearl-ash), carbonate of lime (whiting), felspar, &c., which may be called the fluxing materials.

Flint should be well calcined and ground, as for the body, and it is of special importance that all materials entering into the glaze should be finely ground.

It gives hardness, quality, and transparency to the glaze, and loses in fritting about 3 per cent of its weight.

China Clay, in the same state as used for the body. It gives an appearance of softness and depth of tone to the glaze.

Whiting, or Carbonate of Lime, is chalk which, in its pure state, is infusible; but will fuse at a high temperature when combined with silica, alumina, or alkaline silicates. It improves the colour of the glaze, and makes it harder.

Cornish Stone in a glaze must be looked at from two points of view, as both containing some of the elements of the dry as well as those of the fusible materials. It will fuse by itself at a high temperature, but at a very much lower combined with borax, boracic acid, &c. It gives solidity to the glaze and affinity to the body. It loses about 5 per cent in fritting.

Tincal is found in Thibet, China, Ceylon, Tartary, Saxony, Transylvania, Potosi, and other places. Its usual appearance is that of brownish crystals. That from Thibet is obtained from a lake at a considerable elevation; and the springs for the greater part of the year being frozen, both tincal and salt are deposited on the edges and shallows. It contains a considerable quantity of foreign matter, and for this reason borax is often preferred to it. It fuses easily.

Boracic Acid is obtained in yellowish white thin hexagonal scales, brittle and slightly greasy to the touch; it is formed of one atom of boron and three of oxygen. It has been largely used in ceramics of late years, and since its introduction glazes have considerably improved. It is obtained chiefly from Tuscany, where it rises in vapour jets, and is collected by passing through tanks of water; and when the water is sufficiently saturated it is drawn off and allowed to crystallise. It is eminently fusible. Boracic acid contains fifty-seven parts boracic acid and forty-three parts water. Carbonate of soda is generally used when fritting with boracic acid in the proportion of 44 ½ per cent to the acid.

Fritt made with it is of a light yellowish white colour, loses 33 per cent of its weight, and looks lighter and clearer than borax fritt. It is difficult to obtain always of the same purity, and has been largely superseded by borax, though by many it is still considered its superior.

Borax is unrivalled in its properties of promoting fusibility of vitrifiable compounds, causing them to flow without bubbles or specks, and on account of its known purity is preferred by many to boracic acid. It contains fifty-three parts soda and boracic acid to forty-seven parts water. It used to be manufactured from tincal, but the process was slow and expensive. It is now made by treating boracic acid with carbonate of soda, and the price has fallen considerably. It is sometimes adulterated with alum and salt, and, like all other materials, should be carefully tested and tried before use. All these fusible materials should be carefully tested for moisture, as some of them, especially red and white lead, absorb water with avidity, and, apart from the mistakes that may arise from a given weight containing less real material than it should, it makes a vast difference in the real

cost price, and 5 per cent more water means a considerable reduction in material.

Fritt made with borax is of a bluish-green colour. It loses about 33 per cent of its weight in fritting. It gives great brilliancy to a glaze.

Carbonate of Lead, or *White Lead*, is obtained by oxidising the metal. The two principal methods of obtaining it are the French and Dutch; the former by decomposing the basic acetate of lead by carbonic acid; the latter by bringing in contact the metal steeped in vinegar with the products of decaying manure. Earthenware pots are half filled with vinegar, and lead shavings or rolls are introduced. The pots are then placed in tiers and buried in manure. After remaining some time they are withdrawn, and the white carbonate scraped off from the metal. It then goes through various purifying processes. Many modifications have been introduced, but they are mostly founded on the foregoing processes. It is of a white colour, insoluble in water, fusible at a low temperature.

Oxide of Lead. Red Lead, minium. Lead as a metal is largely distributed, and is sometimes found in the form of oxide, though generally in the form of galena; that is, in combination with sulphur. It often contains traces of copper, iron and silver, and to obtain it pure it must be oxidised.

Protoxide of lead is heated to a certain degree in fine powder, and the flames play upon it while it is constantly agitated. Oxygen is admitted, and the more oxygen it will take up the redder it becomes. Two or three calcinations are sometimes necessary to procure a brilliant red. It fuses with a little more facility than white lead, but gives a slightly yellowish appearance to the glaze.

Carbonate of Soda is generally made by treating sulphate of soda at red heat with chalk and carbon in

certain proportions. Common salt is converted by sulphuric acid into sulphate of soda, and is then fired with sawdust or coal slack, and it becomes sulphurate of sodium; by the addition of lime, or by the dissipation of the sulphur by roasting, it becomes carbonate of soda. Soda ash is used when boracic acid takes the place of borax, and it affects its decomposition very quietly. Sodium with potash forms the fusible elements in most of the alkaline silicates.

Potash, or pearl ash, is one of the most energetic of fluxes. It decomposes boracic acid at a high temperature. It exists in combination with silica in the felspathian rocks, but is difficult of extraction. It is largely obtained by burning vegetable matter in pits. The ashes are removed to tubs, and about 5 per cent of lime is added; water is then introduced, and when it is saturated, is drawn off and dried in shallow pans. When dry it is removed, the result being crude potash. It is then heated in a reverberatory funnel till most of the sulphur and the excessive water are driven off. The loss is about 10 to 15 per cent, and the bluish white residue which contains more carbonic acid than before is the pearl-ash.

Felspar.—There are several different sorts of felspar, but the one with which we are chiefly concerned is known as Orthoclase, or potash variety. It decomposes when subjected to atmospheric influences, and its last stages of decomposition result in China clay.

It is composed of silica, alumina, potash, and traces of lithia, lime, &c., the two former being in very regular quantities, but the alkalis varying considerably. It varies much in colour, from green to yellow, but the fawn-coloured is usually preferred. At a moderate heat it smears, and at a great heat it runs down to a transparent glass. It comes in decomposition between granite and china stone, and is very hard and difficult to grind.

It is therefore better to calcine it before grinding. It gives brilliancy and a waxy appearance to glaze. It is used more in china than in earthenware manufacture.

As regards recipes and mixtures for glazes the same remarks apply as for bodies, and the examples given are merely to explain the process.

As the most general system of applying the glaze is by immersion, it is necessary that all the materials should be capable of being held in suspension in water, both when being ground and afterwards. Besides, several of the materials used would dissolve in water, it is therefore necessary first to vitrify them, as in that state water has no effect on them. This is one of the chief objects of fritting.

Fritting can be carried out in crucibles or even in saggers in the oven, where only a small quantity is required, but for commercial purposes a fritt kiln is a necessity.

The Fritt Kiln is a fire-brick tank in direct contact with the flame. The flames pass from the fire-hole over the bridge, which is really one end of the tank and which separates the combustible from the material to be fritted. The flames are reverberated down on to the material, and then pass out at the opposite end into the flue or stack. The materials are introduced at the top of the kiln by holes covered with fire-clay quarries, and it is as well to sprinkle ground flint round them, to prevent loss of heat and the escape of any vapour from the interior into the fritt house. When ready, the molten material is run off through a hole in the side of the kiln, the bottom being sloped towards it to facilitate the running off. The hole can be closed by an iron door or plate about 2½ in. thick, fitted to a handle. This door fits closely into the aperture from which the mass runs, and when replaced the interstices should be filled

with ground flint to prevent heat and vapour from escaping.

Below the level of the bottom of the kiln, opposite the opening, is a tank of water, and the molten fritt is run by a short, thick iron spout fixed in the opening into the water; there should be a constant current of cold water running through the tank while the fritt is being drawn off, so that the water may thoroughly break up the molten mass to facilitate its grinding afterwards. In fact the deeper the tank, the finer the fritt will be broken up. If it were drawn off without water, it would form a solid mass of glass which would be difficult to break up and grind. The water should run in low down in the tank on one side, and the overflow should be on the top on the opposite side, thus obtaining a circulation of cold water through the tank; there should also be a plug in the bottom, to draw off the water when the operation is completed, to facilitate the collection of the fritt.

Sometimes the fritt will not run out readily, and this is especially the case with the first charge fritted, and it has to be helped out with iron rods with hooks at the end; this is always rather unsatisfactory as, unless great care be taken, the great heat of the kiln will fuse the iron, and bits may fall off into the fritt; and also as the brickwork, on account of the continued heat in contact with the fusible materials, becomes soft, bits may easily be pulled away with the fritt to its detriment. When once the necessary heat is obtained, it is more economical to continue fritting charge after charge till a considerable stock is obtained, working both day and night as long as necessary. Fritt kilns, owing to the continued and great heat to which they are subjected, require considerable repairs and they should always be done with the very best fire-bricks laid in ground flint.

Sufficient water may be mixed with the flint to enable the bricks to be laid. This is far better than using fire-clay or other materials, all of which have more contraction than flint. In calculating the cost of fritt, after deducting the known loss of weight in the different materials, it is advisable to take off a further 3 or 4 per cent for loss in manipulation.

A.

Fritt Mixing.	lbs.	*Mill Mixing.*	lbs.
Borax	120	Fritt	100
China Stone	120	Stone	50
Flint	60	Lead	50
Whiting	80	2 to 3 ozs. stain if necessary,	
China Clay	20	at 25 ozs. to pint.	

B.

Borax	140	Fritt	90
China Stone	75	Stone	100
Flint	75	Lead	60
Whiting	70		
China Clay	25		

C.

Tincal	144	Fritt	90
Stone	84	Stone	25
Flint	66	Lead	35
Whiting	48	Flint	6
China Clay	24		

D.

Boracic Acid	88	Fritt	11
Soda Ash	39	Stone	5
China Clay	37	Lead	4
China Stone	75		
Flint	75		
Whiting	52		

Weighing-out for Fritting.—When the composition has been decided upon, the first operation is to weigh out the materials. This is usually done with an ordinary steel yard and a weighing box, the latter of a size suitable to the quantities to be weighed. A box some 18 in.

each way would be a convenient size, and it should have an iron band passing under the bottom and round the sides, forming a handle over the top, something similar to a bucket, so that a man on each side can easily lift it on and off the steel yard and carry it away between them to empty it. It is better to weigh sufficient material for each charge separately; but if many charges are weighed together they can be heaped up and dug over from side to side on a wooden flooring till thoroughly mixed; but there is an element of doubt in this latter method as to the exact composition of *each separate* charge of fritt, though in the charges taken together as a whole the proportion of quantities is correct.

Great accuracy is necessary in weighing the materials, and there is nothing easier than to make a mistake; so it is as well every now and then to ask the man in charge of the fritting, who is lifting the box from the steel yard, how many boxes have been weighed of any one material? to see if he is paying attention. No one except those employed should be allowed in the fritt-house when weighing is going on, or their attention may be called off and mistakes result.

Weighing for the Mill.—After the materials have been fritted. The fritt must be weighed out with the insoluble materials which it has been unnecessary to fritt, such as lead. After weighing they are sent to the glaze mills to be ground.

Grinding.—These mills are usually round pans with removable wooden covers, and with chert bottoms. Either in large pieces or in small blocks, the latter giving the best results. Great care is necessary to select stones that are hard and that contain little or no iron in their composition. A shaft, driven from underneath, passes through a cylinder in the centre of the pan, and to this shaft are attached the arms, and to the arms are fastened

the blocks of chert which grind the materials. The stones are either pushed or pulled round by a chained attachment. The better mode is to have an iron band round the stone that prevents it moving out of its place, but allows the full weight of the stone to rest on the bottom. When pulled by chains, the stones are slightly lifted and do not grind so well, and when pushed, the material does not seem to pass under so well, but is carried round in front of them.

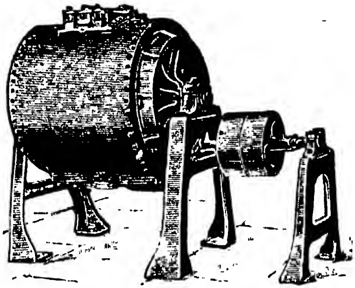
The stones should have one or two grooves cut underneath them from the front, and curving slightly towards the centre where the groove should finish. By this means the material is admitted freely under the stones. The bottom and the stones require frequent attention and picking, or the time occupied in grinding will be considerably increased. Anything from twenty-four to forty-eight hours may be necessary, though time is no guide, as it depends on the mills and the hardness of the substance to be ground.

The glaze must be thoroughly ground till it has assumed a creamy appearance, and care must be taken to add the necessary quantity of water, as some materials grind better with more water, others with less. The mills must not be overloaded at starting, and part of the charge can be put on after the mill has been working a little. Towards the end of the grinding, when the material is getting very fine, the stones are liable to set or suck, and may cause a break-down. The introduction of a small quantity of vinegar, or quick lime, will correct this, but the effect these materials may have on the mixture being ground must be taken into account. Latterly the Alsing Cylinder has come into use for glaze grinding, and it seems to give general satisfaction when used, the glaze being equally well ground, and in less time than with the old mills. It also occupies a smaller space.

The glaze can be tested for fineness between the nails, and when there is no appearance of grit in it, it should be tested with a fine lawn and if ready should be run off or carried into the lead-house.

The Lead-house is the store for glaze materials and glaze, the latter being kept in large tubs, and is sent to the dipping shop as required.

The glaze is first carefully lawned and run into plungers or tubs. In the former case the blunger, instead of having blades attached to the central shaft, has frames



ALSING CYLINDER.

in which a quantity of magnets are placed to extract any particles of iron that may be floating in the glaze. In the latter case the magnets are fixed in a dolly, which is a frame attached to a handle, and is agitated in the tub by hand. A very simple mode of magnetising glaze is to have the tub into which the glaze is first sifted at a higher level than the rest, and then let the glaze run along a trough filled with magnets into the storage tubs. All glaze should be well magneted and kept in stock at least fourteen days before being used. It seems with

age to get more together, to glaze the ware better, to be more economical and to go further, and by always having a stock it gives plenty of time for the repair of mills.

From all points of view it is of advantage to hold a stock of glaze. It is also a safeguard to dip a piece or two in every mixing when run off the mill, to number it and send it through the glost oven. Then each charge of glaze will be tested and proved before it goes to the dipping shop for general use. It is little trouble if done regularly, and its advantages are apparent. One of the great difficulties in potting is to be able to trace any defect to its true cause ; but by checking the various processes in different stages it is easier to say where a defect is likely and where it is not likely to occur.

Mills should have their ironwork painted, and should be kept locked when grinding, so that no one has access to them except the man responsible for the work. When left open, extraneous matters get into them in the most unaccountable manner, and sometimes cause much trouble. For the lead-house and glaze-making a clean, observant, methodical man is required, and no one without these qualities should be allowed in this department. He should keep in the lead-house a list of the dates on which a charge is put on the mill and on which it is run off. By this means can be seen the time taken in the grinding, which shows unerringly the condition of the stones. He should also keep a note of the dates on which the different stones are picked, as some stones are softer than others, and it is well to know beforehand when any particular stone is likely to require attention.

It is even more necessary to insist on cleanliness in this department than in any other ; and all utensils should be kept only for glaze, and no other material under any circumstances should be allowed in them. And apart from the necessities of the business, a dirty man

is nearly sure to suffer from the effects of the lead, while one who is clean will avoid any ill-effects. It is also as well from time to time to send to the dipping shop for a jug of glaze, and this should be carefully lawned; if there is dirt in it you may be pretty certain that the dippers are not sufficiently careful in lawning their glaze, which they should do at least two or three times a day.

The chief defects in the glaze are: crazing, peeling, pinholes, blistering, dryness, unevenness, running, spitting out.

Crazing may be due to the expansion and contraction of the body and glaze not being equal. By examining the quantity and sizes of the crazes some idea of the difference between body and glaze may be obtained. The more crazing apparent the less affinity there is. Improper use of china clays, especially the better class, is a frequent cause of crazing. It may also be due to too great fusibility or softness of the glaze. To too thick dipping, to short firing in biscuit, to short firing in glost. Should by accident the smallest amount of oxide of copper come in contact with the glaze it will cause crazing.

Peeling may be due to want of affinity between body and glaze; an excess of flint, causing the body to have a greater expansion than the glaze, breaks the glaze off at the edges and corners. To short-firing in biscuit, to the use of dirty water in sponging the pieces in the clay state; to insufficient brushing and cleaning in the biscuit warehouse. In these two latter cases the dust or dirt left on the edges really forms an independent body lying between the body and the glaze, and prevents them from properly uniting.

Pinholes may be caused by hardness of glaze, or glaze with insufficient flowing qualities, or under glost-firing,

or badly sponged clayware, or soft insufficiently pugged clay.

Blistering may be due to unequal firing, or to the admission of cold air when the glaze is at the melting stage.

Dryness may be due to insufficient dipping, hardness of glaze, over biscuit-firing, over glost-firing, placing in insufficiently glazed saggers.

Unevenness may be due to insufficient glost-firing, or irregularity in dipping, or infusibility of glaze.

Running may be due to too soft a glaze, over glost-firing, hard biscuit, or over dipping.

Spitting Out.—This defect is generally noticed after enamel kiln firing. The glaze becomes rough and full of little black specks. The real cause is hardly known, but it is generally attributed to the ware being damp. Old ware, which has been some time in the warehouse, is far more liable to this defect than ware fresh from the ovens. It is therefore generally better to decorate over glaze new ware rather than ware that has been for some time in stock in the warehouse. It is often most difficult to tell to what cause a defect is due, and it is only by constant observation and experiment that the true reasons are discovered.

It would no doubt be desirable to obtain a glaze into the composition of which no lead entered, but up to the present no leadless glaze which really meets all the requirements of the commercial potter, as to its adaptability to all classes of work and colour, facility in manipulation and lowness in price, has been proved successful. Leadless glazes have long been known, and there is little difficulty in producing them for certain classes of work, especially when cheapness is not a *sine quâ non*. Many have cried Eureka, but, as far as we know, there is not yet on the market a leadless glaze,

guaranteed by its manufacturer, that can compete commercially with lead glazes—but because a satisfactory solution has not yet been arrived at, it is no reason for supposing that it cannot be attained, and, with many working in the field, it is to be hoped that ere long the desired result will be gained.

There are certain persons who are predisposed to the effects of lead, and these of course should not work in any department where lead is used, but by far the greater number of cases of disease from lead are directly caused by want of cleanliness, and by inattention to the most ordinary precautions when dealing with deleterious compounds. It is another case of familiarity breeding contempt.

CHAPTER V.

MODELS AND MOULDS: PROCESSES AND MATERIALS USED IN THEIR MANUFACTURE.

In olden times the chief method employed in the manufacture of pieces was by "throwing" on the potter's wheel, designs of which have come down to us on vases and on other materials, both from the Chinese and Egyptians, and this appears to be the only practical means by which truly circular pieces can be made by the hands without any further appliances. Though still in use, it may be said, from various causes which will be afterwards referred to, to be gradually falling into desuetude, and the majority of pieces are to-day made with the help of plaster moulds in one form or another. It will, perhaps, be better therefore to discuss the manufacture of moulds and the models from which they are made before referring to the manufacture of ware generally.

Almost any shape can be fashioned by the ceramic art, but it is evident that some forms and designs lend themselves better to the manufacture than others. Where cost is no object and artistic productions of the most varied form are required, the modeller can, of course, have full scope for his inspiration, but it must not be imagined in commercial manufacture that he can be allowed an absolutely free hand. There are certain hard and fast lines from which he must never depart, such as facility of manufacture both in moulds and actual making, subordination to the requirements of the painting afterwards to be applied, the taste of the market for which the goods are being produced, &c., and it therefore often

happens that a man who is artistically an excellent modeller is of little use to the commercial potter. The modeller's object should then be to make models of beautiful design which at the same time can be produced with few defects, small loss, and at a reasonable price, that is to say, of sufficient facility in manufacture to enable the workmen to earn a fair wage with a large production.

Far the greater quantity of earthenware is for useful and commercial rather than purely artistic and decorative purposes, though beauty and utility should always be combined whenever possible; but beauty must not be confounded with the curious and the elaborate, as many of the most simple forms are the most beautiful. It is therefore necessary that the modeller should understand the different processes of manufacture in order that his models should not offer excessive difficulty to the mould-maker on account of "under-cutting" or ornamentation that will not "deliver" easily, which necessitates many parts to a mould; nor to the worker who has to introduce the clay and afterwards stick together the various parts; nor in the ovens, where the pieces must have sufficient base to stand on to prevent them going crooked, unless they are to be placed upside down. Pieces that have to be propped up with various supports must always be expensive on account of the time employed in arranging them. He must also bear in mind the contraction, so as to avoid different thicknesses—a fruitful cause of distortion.

It must also be remembered that the clay piece while in the mould dries and therefore contracts—the model must be made in such a manner that the contraction takes place "away" from the mould, otherwise the piece would either split or would not "deliver" from the mould when the time came to take it out.

An important point, too, is that the size of the piece will never be the same as the model; the moulds are made in plaster, and before the working moulds are obtained from the model at least three casts have to be made; as with each casting the plaster swells about one-hundredth, and therefore the piece when *first made* from it would be slightly larger than the model, and in the case of flat there are four swellings, though five castings, as the working case being hooped does not swell outwardly. In drying and firing the clay contracts considerably, the contraction in ordinary earthenware body being one-twelfth, or about 8 per cent, and consequently the piece when finished is considerably *smaller* than the original model. It must here be remarked that a difference between hard and easy firing will cause great variation in the size of pieces from the same moulds; and the modeller can only allow for the *usual* contraction, so that any pieces that are required exactly to size must be fired in that part of the oven where there is the least variation.

He should avoid acute angles and corners and excessive thinness when sharp corners have to be made, as they are almost sure to crack during the manufacture. Any parts projecting from the body of the piece are undesirable, such as arms and legs in figures, as they would have to be propped and so the expense of production would be greatly increased. It is most essential with the introduction of machinery that the models for circular pieces should run exactly true, and therefore the modeller must be able to turn his models absolutely correctly to the centre. This is of the highest importance, as it is impossible to work with untrue moulds or machinery.

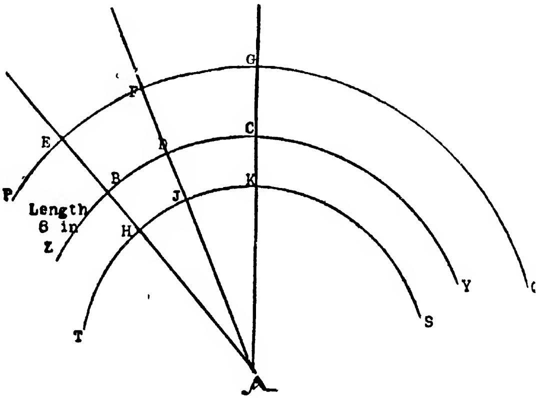
One of the commonest tasks required of the modeller is to make a model that will produce a piece of ware the

exact shape and size of a sample given, or to make from one piece a scale of pieces either larger or smaller than the sample. In the first case, he has to add on the contraction of the clay to all the different measurements of the sample, and form his model to these dimensions. In ordinary work there is no occasion to take into consideration the swelling of the plaster, which would hardly affect the piece in practice. In the second case he would have to make his model of the piece in the same way as above, and then work out each of the various dimensions by a simple proportion sum.

It is of great importance that scales of articles should be made accurately, as, apart from the appearance, they must "nest well", that is, fit inside each other at equal distances to facilitate firing them in the ovens. A simple way of obtaining all the different sizes and proportions of a scale of articles is to take one measurement, say, the length of a piece, and describe a circle with that measurement as radius, which afterwards may be produced outside the circle; along the circumference of the circle from the point where the radius joins it, measure the different parts of the model, and through these points draw radii from the centre, producing them outside. Any other size can be obtained, either smaller or larger, by marking the length required on the radius first drawn, either inside or outside the circle, and then through this point with the same centre describe another circle, cutting the other radii. Measuring the distances along the circumference of this new circle will give all the measurements required for the piece of this new length.

Let us take a dish as an example, but with only some of its measurements, so as to avoid confusion. The dish is then 8 inches long, 5 inches wide, and 2 inches deep, and it is required to make two other dishes 10 inches and 6 inches long, and in the same proportion.

A to B is the length of dish 8 inches, and the line is produced outside the circle ZY. B to C is the width 5 inches along the circumference ZY. B to D is the depth 2 inches along circumference ZY. Draw the radii AD and AC and produce them outside the circle ZY. To make our 10-inch dish, measure 10 inches from A, past B outside the circle to E, and with radius AE describe another circle PQ, and the points where the new circle



cuts the produced radii, measure to E along the circumference of the circle PQ, give the dimensions required. That is to say, the distance between E and F is the depth, and between E and G the width of the 10-inch dish. In like manner for the 6-inch dish, measure 6 inches from A to H and describe circle TS. H to J is the depth of the 6-inch dish and H to K is its width. In this manner any number of different measurements may be made, such as height, breadth of edge, slope

of edge, &c., and so any number of sizes can be scaled either greater or less than the sample.

It is as well, when there are many measurements, to note down what they are to avoid making mistakes, thus:

A to B = length.
B to D = depth.
B to C = width.

Models may be made of any material; in fact it is evident that any substance from which a plaster cast can be taken may be used as a model. Metal, wood, marble, papier mâché may all serve their turn. But the substances generally employed by the modeller are wet clay and plaster.

Wax is probably the best of all materials for the modeller's use; that is to say, if no after-processes had to be taken into account he would prefer it as a material to work in. But it is not in general use, except for fine work such as cameos &c., as the plaster absorbs the oily surface of the wax and spoils the model.

Clay is an admirable material to work in, and adapts itself with great facility to the modeller's requirements. It is therefore largely used. It is a little difficult to secure the necessary finish and perfection of detail in the models, and to cast good moulds from them the greatest care is necessary, as, once used, even if extracted without breakage, they are of no further use, consequently the block mould is always preserved and therefore becomes the model.

Plaster is a largely used medium for making models. It is hard enough to procure perfect outline, and yet not too hard to work in, though, when the model is finished, it can be made still harder by the application of oil. Great care is always necessary in blocking a

model, as plaster models may also be easily broken. The handles, knobs, and ornamentation are made from clay, and a plaster cast is taken of them for future reproduction; sometimes a clay model is made plain and then a plaster cast taken of it, and a plaster lump run and the various decorations are affixed to the plaster lump and the whole cast again. When taking casts from plaster, the model must be sized with a mixture of about half-a-pound of soft soap to a pint of water. For plain pieces, of which there is a very large and unfailing consumption, it is sometimes advisable to have brass or gun-metal models which are practically indestructible, though very expensive in their first cost. For taking casts, they must be sized with linseed oil and cleaned with turpentine.

The modeller's tools consist of compasses, files, gouges, and chisels of various forms and shapes of steel or iron for plaster, and of wood for clay work, and he requires a whirler, and in some cases a lathe, in his shop.

Models are multiplied to such an enormous extent, not only by the moulds produced from them but by the thousands of pieces made from these moulds, that the greatest attention should be paid to them; otherwise the market is flooded with inferior designs which tend rather to debase than to elevate the standard of taste.

Moulds are a very costly and, perhaps, the most cumbersome part of the potter's stock-in-trade. There must be moulds of every size of every piece that is required, from the most elaborate vase to the simplest saucer. They are made in one or more parts, as may be necessary for the manufacture of the piece. Plate and flat working moulds are generally in one piece which forms the front, the back being made by the tool or profile. Other shapes, such as ordinarily shaped cups and mugs, are also made in one part moulds. In this

case, the tool forms the piece inside the mould. Moulds in many parts, for the manufacture of sugar-boxes, ewers, &c., may be described as plaster boxes, which once held the model, and therefore the clay, being pressed into them, receives the same form and shape as the original model. They have to be made in such a way that after the clay has been applied to the various parts of the mould, and these parts have been placed together, room is left to work the joints of the clay together, either by hand or with a tool

Metal moulds of lead and tin used to be employed in pottery, but non-absorbent materials are unsuited for practical mould-making, and now-a-days the substances in use may be said to be reduced to two: fired clay or pitcher, and plaster. Moulds made from the former give very clean, clear impressions, and last considerably longer in good condition than plaster, but they labour under two disadvantages. Firstly, they cost considerably more in the first instance; and secondly, they are only slightly absorbent, and on this account a much larger quantity of them are required for quick production than if made of plaster, as they take a considerable time before the clay has dried sufficiently to admit of the clay piece being extracted. Pitcher is still, however, considerably used for cup handles and small parts, and also for leaves, garlands, and ornamentation which are afterwards applied to Jasper and Basalt ware vases, &c. In this case the clay is pressed into the mould, and the superfluous material is removed by scraping the surface with a knife; and, were this class of mould to be made of plaster, the knife would destroy the surface in a very short time.

Moulds are also made from brimstone or sulphur and are used more especially for leaves and raised flower work which are afterwards fastened to the ware; they

are also harder than plaster and are not worn down so much by the knife; they should, however, be oiled before use.

All moulds of any size are made of plaster, on account of its facility in working, and its great absorption of water, and its only disadvantage is that by constant wetting it is liable to become rotten and perish. They last longer when thoroughly dried between the manufacture of each clay piece off them, and new moulds which are first thoroughly dried and then put in work for a short time, and then again thoroughly dried, when put into regular work become much harder and last much longer than those which, after being only once thoroughly dried, have been put into continuous work. They should be dried carefully at a moderate heat, and the longer they are drying the better. If the moulds are in more than one piece, the parts are held together by "natches", which are either of plaster or pitcher; in the former case they are cast in the plaster itself, in the latter they are made of clay and fired before use. They are a most important item in mould-making, as without them the different parts of the mould would not fit exactly together without movement.

Moulds, when made in several parts, should be put together and then dried, and should not be dried separately. This applies specially to moulds that are to be used for casting.

Natches are called hump and hollow, one half being the hump, the other the hollow. The hump is a sort of a round stud that fits exactly into the hollow without any lateral movement. The pitcher natches are stamped out of clay by a machine with dies of the necessary size. The hump and hollow should be fitted together, and be thus fired in a regular part of the oven, for if fired separately it is difficult to fit them afterwards, as the

slightest variation in the construction would prevent them fitting with the necessary exactitude, and a certain amount of play would result, detrimental to the accurate fitting of the parts of the moulds. The position of the natches in the moulds also requires study, and it must be left to the judgment of the mould-maker to decide; for if placed too near the edge they may break out in working, and unless placed with care the parts will not properly hold together.

The models, when finished by the modeller, are sent to the mould-maker to make the necessary moulds from them. The mould-maker should have served two or three years in the presser's shop, so as to have acquired a knowledge of the working of moulds and the difficulties in making pieces which arise from insufficient care in the construction of moulds, and he can thus learn to make them in such a manner that the clay pieces will "draw" easily from them and will not split in certain parts from inequality in thickness, &c., and he will also have learnt the most convenient point for dividing them, both for facility in working and to hide the seams or joins in the clay. This is very important, as by putting them at the corners or at some point where the embossing or fluting lends itself to it, they may sometimes almost be hidden

Moulds must dislocate easily without pulling away any part of the piece inside, and, if in several parts, they must join very closely, or the seam will be too visible, owing to the clay being pressed into the joints, and however carefully this seam may be cleaned off, and though before entering the oven it may be quite invisible, after firing in biscuit it will be plainly seen, especially if it gets an extra hard fire, and after the glost fire it will be even more apparent. It is therefore highly necessary that seams should be as small as

possible, and therefore the closer the different parts of moulds fit together the better the result.

On receiving the model, the mould-maker looks it over carefully to see that it is correct, and to decide into how many parts it must be made; if a round piece to be made off a machine, he tries it carefully on the whirler, as the revolving table of the mould-maker is called, to see that it is absolutely true. In the case of a plate model, it should always be centred from the shoulder or ball and not from the outer rim, as this may not be exactly true, especially if the edge be scalloped or vandyked; and it may be taken as a general rule that all embossed or fluted models are slightly untrue, however carefully they have been made.

In making moulds for "pressers", such as jugs, ewers, sugar-boxes, &c., there are three operations to be gone through.

The "block" mould (which is of the same form as the working mould) is made from the model. This mould is always kept in case of damage to the model, for as the "case moulds" are made from it, it is of equal value with the model. Let us take a jug model as an example. First of all the centre of the model, both at top and bottom, must be measured with the compasses and marked with a pencil on both sides from top to bottom, thus dividing the model into two equal halves. A piece of clay about half an inch thick is then pinned or nailed on to the top and bottom of the model, and bevelled off towards the centre, just leaving the edge of the bottom or top visible all round. Then take two bats of clay about 2½ in. thick, and sufficiently dry not to bend, and cut them out to fit closely against the sides of the model from top to bottom. These are called the side-sets.

The model is then placed on the whirler on its side,

held in position exactly level by a piece of moist clay. This is easily seen by measuring from the centre line to the whirler with the compasses. The side-sets which have been cut to fit the model are then placed exactly level with the centre of the model along the pencil line, and are propped up with clay from underneath. The model then has the appearance of being buried exactly up to its centre in clay. Two plaster bats are then placed one at each end of the model and rounded off to the shape that may be deemed most convenient for the exterior of the mould, and a pencil line should be drawn across them horizontally, exactly at the same level as the side-bits.

The model is now sized with a mixture of soft soap and water, heated together (about half a pound of soft soap to every pint of water), to prevent the plaster sticking to it when poured over. The hollow natches are then placed face downwards on the side-sets and arranged in the most suitable place, care being taken that they are not too near the edge, as they may break out from the mould; and yet in such a position that they will prevent any movement when the parts of the moulds have to be joined together

If the natches are to be of plaster, a little half globe of clay is placed on the side-sets, the plaster is then run on, and after it is set the piece of clay is picked out and thus leaves a little round hole or hollow natch; when the other half of the mould is made this hollow natch is filled by the plaster, and thus the hump natch is formed on the other half of the mould, and the natches thus fit absolutely true. Pitcher natches are stronger and wear better, but in many moulds both are required to hold the different parts securely together. Clay bats or "cotters" are then arranged round the model, held in position by string at sufficient distance from the model

to give the requisite thickness to the mould and arched over the model, a hole being left at the top for the introduction of the plaster. The plaster is then poured in and, when set, the clay bats are removed and the outside of the plaster scraped off with a steel scraper to the shape of the plaster bats at each end. We thus have *half* the block mould made.

The half block mould with the model still in it is now turned over and again fixed level. There is no occasion for side-sets of clay this time, as the half of the model already made forms these The hump natches, if of pitcher, are now placed in the hollow natches; the plaster batts at the two ends are fixed at exactly the same height as before, the pencil line drawn across it on the previous occasion serving as guide. The clay bats are again ranged round and over it, and the plaster poured in. When set, the bats are removed, the mould scraped off level with the plaster bats, and the model then taken out. The natches have set firmly in the plaster and hold the parts firmly together, making the joints close.

The *Block Mould* is thus finished, and we now proceed to make the *Case Mould*, which is like the original model, except that it is divided into two or more parts as may be necessary, each part being fixed to a flat base of plaster. These are made merely by sizing the block moulds and pouring in the plaster, and it is from these case moulds that the working moulds are obtained by again repeating the process of sizing and taking plaster casts.

Handle Moulds, &c., are made by introducing the model into a flat bat of clay exactly up to its centre; it is then sized and the natches arranged in their proper position. Clay bats or leather bands are placed round it and the plaster poured in. When set it is turned over,

the hump natches placed in the hollow ones, and the same operation gone through again. Thus the block mould is made.

Round the actual mould of the handle the plaster is slightly hollowed away to enable the extra clay to escape from the cavity of the mould; without this precaution, when the clay is introduced the two halves of the mould would not fit closely and the result would be an imperfectly made handle with too large a ridge at the joint.

The block mould is sized, and from this in the same manner the case mould is obtained, and from the case mould the working moulds are again cast.

Plate Moulds are required in such quantities and for machine work so exactly identical and running so absolutely true that the number of operations for making the working models has to be increased. The model is received from the modeller the exact concave form of the inside of the plate, either with or without spare edge on it.

If the plate is scalloped or worked on the edge, probably without spare edge, as for facility in working the modeller would have turned it off. The mould-maker must therefore put it on again by making a spare edge of clay. The mould-maker should first see that the model is absolutely true in every sense by trying it on the whirler, and, as we have before mentioned, this must be tested from the shoulder of the plate and not from the edge, as all deeply embossed work, and especially flutes, are invariably slightly untrue.

The next proceeding is to make (1) the Block Mould. The model is placed on the whirler and a leather band is placed round the model at a distance sufficient to form the mould of the strength required. After sizing the model, the plaster is poured in. Whenever a little

more plaster than is necessary for the mould has been blended, pour the remainder on any flat surface and it will make a plaster bat which will always be useful. When set, the leather band is removed, and the mould-maker must carefully take the measurement of the jigger-head in which the working mould will eventually run, and allowing a trifle for the swelling of the plaster, must turn the natch or bevel which fits into the jigger-head; and in doing this the greatest care must be taken that the back of the mould is exactly level. After turning the natch, the mould is removed from the model and the spare edge is turned down at the same angle as the brim of the plate. The beginning of the spare edge thus forms the outline of the edge of the plate, this being the guide to the workman for the size of the plate when fettling it.

To make the *Case* (2) the block is first sized and then centred on the whirler, and a clay set made all round it, touching the spare edge, about $2\frac{1}{2}$ in. wide, to give the necessary strength in plaster to the case.

Natches are now put on the clay, and in flat moulds they are almost universally of plaster. The leather band is then put round and the plaster poured in. The band is then removed and the superfluous plaster turned off; this is half the case mould. It is then turned over with the block in it, resized, the leather band arranged round it and filled up again with plaster. When set the band is removed and the mould cleaned off, and this forms the back of the case or really the natch or bevel on the finished working mould that fits into the jigger-head. We thus have the *Original Case* (2).

The case is then parted and the block removed. The two halves of the case which form the front of the plate, and the back of the mould that fits into the jigger-head are then resized, placed on the whirler and the

leather band again arranged round. The plaster is poured in and when set, turned smooth, the cases are opened and the result is the *Double Case* (3) which is again like the model but with the spare edge on and the necessary strength required by the working case.

Great care must be taken in original and double cases, not to run the second half till the swelling is finished in the first half; in fact till the plaster is quite cold, or the result will be "rocking" or movement between the two parts and the working moulds will be untrue.

From the double cases the *Working Cases* (4) are made by taking casts in the manner already described; but instead of covering the whole mould with plaster, the plaster is run up level with the top part of the natch for the jigger-head. The plaster is bevelled off from the natch, thus leaving a sort of funnel by which the plaster can be run in, in the next operation of making working moulds. Before running in the plaster when making the working cases a hoop-iron band of the size required is placed just inside the leather band and so adheres to the plaster when set, preventing it from swelling outwards, and holding the case well together, and the joints thus fit close together and slobbering out when making working moulds is avoided. Neither block, original case, nor double case are hooped, but the working cases always should be; so there will be swelling in all operations except in the making of working cases, the working moulds made from these cases also having their swelling.

We have now the Working Cases (4) made, and though not absolutely necessary, they should be well dried, because moist plaster is not rigid, but slightly pliable, and if plaster is run into cases freshly made, they are likely to warp.

To make the working moulds, the working cases are well sized and the plaster is run in, and when set they are extracted, and the seam, where the two parts of the mould join, is cleaned off, and after being thoroughly dried they are ready for use.

We have thus, to obtain working moulds for plate-making by machinery, five processes to go through: (1) Blocking; (2) Original Cases; (3) Double Cases; (4) Working Cases; (5) Working Moulds. Working plate moulds should be thoroughly dried before being used. If worked directly they are made they will last but a very short time. If, after being in use some time, they get worn and a little rough, they can be sand-papered and flannelled; this puts a fresh face on them, and they can be put into use again. Much sand-papering is, however, unadvisable, as it wears down the surface of the moulds, and if they are put to work with new moulds on the same machine, some plates would result thick and others thin. With reasonable care a round of 50 dozen plates should last, in regular work, four or five months.

Cases should be made of well-blended plaster, and as soon as properly set, say after a quarter of an hour, they should be taken out of the moulds and doused with cold water, and wiped over afterwards with a sponge. When cases have been heavily sized, little pieces sometimes chip off, and the moulds run from them would show slight roughness; but this can be removed by polishing with flannel. If one working case has been hooped and another is required, that must also be hooped, or the working moulds would be of a different size, owing to the swelling of the plaster. For the same reason, if one half of the case is hooped, the other half must also be hooped. For Jolly moulds, made in two or more pieces, the outer part of the double mould can have a piece of iron wire, about the size of thin telegraph

wire, cast in it; this prevents it swelling and holds the interior parts of the mould well together, avoiding large seams in the piece when made.

New cases that have been put to dry, or old cases that have been unused for some time, should be soaked in water before being used, or the newly blended plaster, when poured into them, will damage the cases and render them rough. All moulds must be made thick enough to stand the work for which they are intended; but at the same time should not be made thicker than absolutely necessary, both on account of the extra material used in their manufacture, which makes them more costly, and the additional weight, which makes them more cumbersome in handling. The plaster for cases should be *harder* than that for general moulds; that is to say, there should be more plaster and less water in the blending Should the cases be soft, and the plaster poured into them be harder, they will assuredly be spoilt. Moulds for casting are made in much the same way as other moulds, but it is only necessary to leave a small hole for the introduction of the slip, which is poured out again when a sufficient coating has been formed on the mould. The top mould should be of rather softer plaster and more porous, so that it should deliver easily; that is to say, the plaster should be blended with more water and less plaster when mixing.

It is evident that in making moulds for different pieces, there must be variation in the procedure, as every model requires slightly different treatment, though the principle is always much the same. Mould-makers also vary considerably in their methods, and two men to whom the same model has been given will often make the moulds in a different manner, according to their individual predilections, though the final result will be the same in either case. We have roughly indicated some of the

methods, but it is only at the bench the art of mould-making can be acquired and the detail understood.

An accurate list of all models, cases, moulds, &c., should be kept by the mould-maker, and whenever new moulds are made, or old ones thrown out, the quantities should be noted and the date entered in the book kept for the purpose. So that at any moment the exact quantity of moulds in existence, of any piece or shape, may be at once ascertained without loss of time.

One mould-maker should be told off to look over moulds in work. That is to say when any shape has to be put in hand, he should see in what condition the moulds are when handed to the workman, and note the condition when returned to the mould store, so as to see that they have not been unfairly treated. Any moulds that are in general use he should look over after every month's working, throwing out the bad moulds, and replacing them as soon as possible by new, to keep the full number of the "round" up. No workman should be allowed to throw out any moulds till they have been passed by the mould-maker, and he must always produce for inspection the number of moulds he originally received in whatever state they may be broken, or what not.

This is a great check on carelessness, and prevents breakage and ill-treatment of moulds; and the time spent by the mould-maker in this supervision is repaid again and again by the greater duration of working moulds. It is not much trouble to keep small books for the current shapes, and at the year's end they serve as a useful basis for calculations of the cost of mould-making compared with the amount of ware produced. Every mould should be marked in the original "case", with both its name and size, and thus every working mould will also have its name and size on it,

which is most useful, especially when there are many sizes of the same shape, and all possibility of error is thus avoided.

Plaster, the material of which moulds are made, is worthy of some study. It is preferred to all other materials on account of its power, when dry, of absorbing the moisture from clay in contact with it and for the ease with which it can be manipulated.

It is obtained from gypsum or sulphate of lime. The plaster stone is found in many places, and the method of preparing it is to first break up the stone and grind it finely; it is then passed through a fine sieve and evaporated in a long trough made of fire-clay quarries under which pass flues leading from the fire-hole at one end to the chimney at the other. This is called boiling, as the moisture, in escaping, effervesces. It is moved about with a sort of wooden rake till, at a temperature of about 160° F., it is completely prepared, and solicits combination with water or other liquids. When mixed with them it becomes very hot and rapidly solidifies. After being boiled it again requires sifting, as the finer it is the more durable and closer are the moulds, and the impressions and designs made with it are sharper and clearer.

A good way of sifting is to have a hollow cylinder of wire lawn, placed at a slope in a frame, with a handle attached to it, by which it can be turned round. The plaster is introduced from a hopper above, into the centre of the cylinder, and when the handle is turned the fine plaster falls through the lawn into a box below, and the coarser, which will not pass through, runs down the interior of the cylinder into another receptacle placed at the lower end.

Plaster is much modified by irregularity in boiling. Overboiled plaster swells more than plaster which has

been properly prepared. Underboiled plaster takes longer to blend, and does not so readily mix with the water, and is very deceptive to any but thoroughly experienced hands, as it is not sufficiently absorbent. If it is much underboiled it will not set, and, though apparently very hard when making the moulds, in use it soon perishes. Underboiled or undermixed plaster seems to go on absorbing when poured into a case, and it will absorb the size on the case, and even the surface of it, making it rough, and thus spoiling it. In talking of plaster-blending, hardness is due to more plaster, and softness to predominance of water.

Plaster should be mixed till it just begins to set; that is to say, if it sticks sufficiently to the fingers to form a slight coating over them, it is about the right strength for moulds, but for cases it should be rather thicker.

Properly boiled and mixed plaster causes a slight sweating on the face of the cases when poured into them, and this assists the delivery of the mould, and it seems also to have a hardening effect on the case.

Overboiled plaster solidifies with small lumps as soon as it is mixed with water; and so hard are they that they can only be broken with great difficulty. If poured in this condition into the cases, the small lumps fall by their weight to the bottom of the case, that is to say, to the face of the mould. Should these be plate moulds, for example, after a few weeks' wear, these lumps being harder than the surrounding plaster, work up plainly on the surface, to the detriment of the ware.

Pure water is required for blending plaster. Should it contain salts, or alkalis, the plaster is affected, and the moulds soon become unfit for use. Casters sometimes put salt or soda in the slip to facilitate the delivery of the piece from the mould; but this on no account

should be allowed, as it is ruination to the moulds. The use of dirty water in blending seems to increase the swelling of plaster; and moulds made from plaster blended with dirty water soon rot and perish. Plaster generates great heat when mixed with liquid, and it is always best to use plaster that has been freshly boiled, and it is not advisable to keep a large quantity of boiled plaster in stock.

Many attempts have been made to grind up the old moulds again and remake them with a certain proportion of new plaster; but it is very doubtful if it is really economical, as the moulds thus made are soft and appear to last but a short time, and seem to have lost their absorbing power; but any means by which plaster could be used again would be much welcomed, as the quantity of moulds destroyed during the year is enormous. In fact, one of the few uses old moulds are put to is in the ovens, a layer of moulds being laid on the fire-bars before lumping the mouths with coal. They protect the bars and retain considerable heat without flame. They are also sometimes used to check the fire a little if one part of an oven burns too fast.

CHAPTER VI.

THE MANUFACTURE OF ARTICLES FROM CLAY, AND THE VARIOUS METHODS EMPLOYED.

THE methods of manufacture may be broadly described as four: *Throwing, Pressing, Casting, Stamping out with Dies.* There are many variations and applications of these methods, such as the making of handles, which is a sort of pressing. The manufacture of plates by machinery, which is a combination of pressing and turning, &c., to which reference will be made in due course.

Throwing, as the forming of pieces on the potter's wheel is called, is probably the most ancient method of manufacture, as, before its invention, clay vessels could have had but little symmetry of shape, and it is by far the most interesting process to watch. The skilled operator, with merely a formless mass of clay on the rotating wheel in front of him, with no other appliances than his hands, will transform it into a vase in a few seconds, and after reducing it back again to a lump of clay, will form other vases or chalices, with endless variation of shape and form. In no other art is there such scope for individuality and originality, and it is this, coupled with the apparent facility with which the forms appear and disappear under the thrower's hands, that makes the work so fascinating to the onlooker.

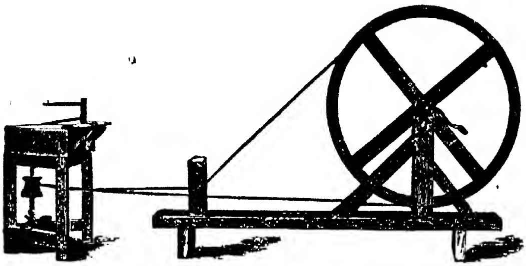
It is difficult to fix the time or place of the invention of the potter's wheel, and the necessity for some such contrivance must have been early felt, and no doubt invented by several nations. It appears to have been known in China in the earliest times, as the most ancient

pieces of Oriental porcelain known have evidently been made on the wheel. In Egypt it must have been in use for some two thousand years B.C., as witness the mural decorations of the tombs at Beni Assan and Thebes. It is referred to in Holy Writ, and was at work at an early period in Assyria.

Homer mentions it in the Iliad, Book XVIII, line 599 to 601, in describing a dance. Its invention was *claimed by Athens for Coroebus, by Corinth for Hyberius, and for Daedalus or Talus by the Cretans.* The Greeks indeed considered it such an important discovery that they thought it worthy of being immortalised, and so medals were struck with the representation of a vase made on the potter's wheel, and an owl, the emblem of Minerva, on them. Others consider that it was introduced into Greece before this period, and Birch remarks, "the very oldest vases of Greece, which are supposed to have been made in the heroic age, bear marks of having been turned on the wheel." It appears, however, to have come to Greece from the East, and though we have said it was probably discovered by more than one nation, yet there are some races to whom it never can have penetrated; for instance, there are no pieces of ware made by the aboriginal inhabitants of either North or South America known which give evidence of having been made on the potter's wheel.

In its simple form it is a disc of wood of varying size fastened on the top of a vertical spindle which is made to rotate, probably in the first instance by the hand of the potter or an attendant. Afterwards a wooden wheel was fixed to the lower end of the spindle, which was kicked round by the foot of the workman or poked round by a stick. Later on the movement was supplied by a cord or strap running round a small pulley attached to the spindle and over a large wheel turned with a

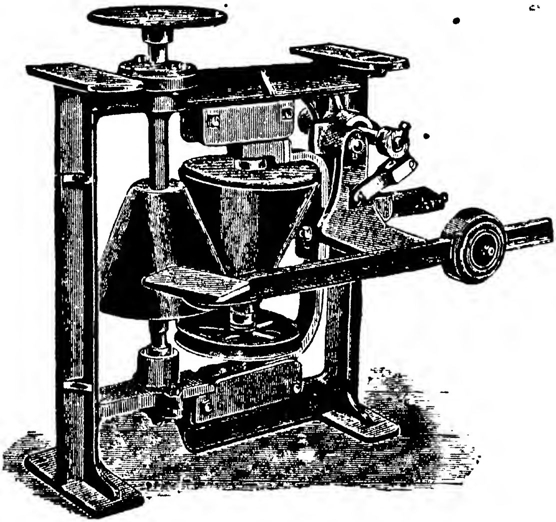
handle by an attendant; and the modern wheels are turned by either steam or water power, and by a system of cones and breaks the speed can be changed and regulated at the will of the operator. This is of great importance, and in the former cases the speed had to be changed by word from the thrower to the attendant, till the latter by practice could follow every movement of the thrower's hands and change the speed in accordance with his requirements.



THROWER'S WHEEL.

If the thrower is given the sample piece of ware which it is wished to make, he would have to calculate the necessary increase of size he must give it to allow for the contraction in firing, and unless he is a thoroughly experienced man this is liable to lead to mistakes in sizes. It is always better to give him the measurements both as to size and thickness, or a model of the piece as he is to make it for the turner, and not the size that will result after firing. With an experienced man, however, a fired piece is a sufficient guide, and the usual custom is to work from the finished model. He first then makes a sample piece of the shape required, and having got it as he thinks right in every particular,

he cuts it in half to see that it is of the requisite thickness and, if satisfactory, he places it in one side of the scales which his attendant uses to weigh the balls of clay in, so that once the weight is decided on every ball of clay is of the same weight, which conduces to the regularity of the pieces both in weight and size.



POWER THROWER'S WHEEL.

The attendant, before making the balls, should "wedge" the clay thoroughly, so that it is as near as may be of the same consistency.

The thrower has a movable sliding gauge with a revolving horizontal arm or pointer attached to it, and conveniently placed for the measurement of the piece

during manipulation, and as soon as he has made the first piece to his liking the gauge should be fixed at the requisite height. He should also have compasses and callipers for measuring both the interior and exterior and also the thicknesses; these with various pieces of horn, pitcher, or copper, and a small sponge or two fulfil all his requirements in the way of tools. Sometimes a considerable number of these pitcher tools will be required, as each distinct shape necessitates a separate tool, and great care is necessary to have the tool of the right form for the inside work when ware is required "to measure", that is of a fixed capacity.

The disc of the potter's wheel is generally of wood, though sometimes of copper; and some throwers prefer to fix a plaster batt on the disc with a little slip, as the piece comes away more easily when finished and has not to be cut off with a wire as it would have to be in the case of wood or copper. The plaster batt should always be dipped in water before being placed on the disc, otherwise it would absorb the water from the clay too quickly, and the piece would probably become detached from the plaster before it was finished.

The thrower, when seated before his wheel, is handed one of the clay balls previously weighed by his attendant. He then dashes it down on the revolving disc and by the pressure of his fingers, which he dips in a bowl of water placed conveniently near, the unformed mass rises and falls, expands, contracts from a cone to a flat mass, till the clay is thoroughly homogeneous and free from all chance of air-bubbles. He now makes it take the form he requires, and by inserting his thumbs in the centre of the mass, and by pressure, forms the interior hollow as the clay walls rise between his thumbs and fingers. He works it gradually into the thickness required, moistening his fingers from time

to time with water. This is important in order to keep the clay all of the same density as, were he to continue working without wetting his hands, the heat from them would dry the clay which was in contact with them and form a sort of crust outside which would prevent the interior of the clay drying equally, and the consequent result would be distortion. The clay would also stick to his hands, and the smoothness of the surface of the piece would be destroyed.

The receptacle containing the water should be emptied from time to time and refilled with clean water as it becomes full of "slurry". When nearly the right size, he takes one of his pieces of horn or pitcher, which are called "ribs", the edge of which represents the curve of the vessel, and with this he smooths the inner surface and gives it shape; should any slurry be left in the interior he cleans it out with a sponge. In small pieces he would only use his fingers and not finish them with a tool.

Some pieces are thrown with little or no shape, but the nearer the thrower can approach to the finished shape required the better, as it means less work for the turner who follows him; but he must always be careful to leave sufficient thickness, or the piece will be cut through by the turner and spoilt. Some pieces which are closed at the neck are thrown in two parts and are afterwards stuck together. The piece, when finished by the thrower, is cut off from the wooden bat by a wire and taken to the drying stove till it is in condition to be turned. In the case of very large pieces extra discs or bats are required, so that the piece may be allowed to dry on them in order to avoid having to cut them off, which might warp them.

The alternate raising and depressing of the clay on the wheel by the thrower not only gives more homogeneity to

the clay, but it probably gives it more stretching power, so to speak, and the operation of making the piece may almost be considered to be like winding a filament of clay spirally into the form required. All the molecules are thus stretching in one direction and in drying the contraction would also be in the same direction, and it is probably partly due to this reason that the contraction of thrown pieces is less than that of pieces made by other processes. As the piece rises care must be taken to clean off the "pulp", as the slurry formed by the clay and water is called, as, should it be worked down again into the piece, it is sure to cause cracks, especially in solid pieces such as insulators.

Good throwing is of the highest importance, as the defects often do not show till after the firing, that is, to say, till all the expenses have been incurred of turning, handling and firing the pieces, &c., and when no means of remedying the defect are possible. Nothing is easier for the thrower than to cast the onus of the defect on the turner, handler, or fireman, or anyone through whose hands it has passed, when really he is responsible for the initial defect. The following are some points worthy of remark :—

1. The clay must not be too soft; a very plastic clay is really more difficult to throw well than a "shorter" one. Not that it works with more difficulty—quite the reverse—but any inequality in pressure shows much more after drying and firing and therefore defects are more apparent.

2. The thrower must not apply unequal pressure to different parts of the piece.

3. And above all, he must graduate the vertical movement of his hands to the rotary movement of the wheel, or *vice versa*, so that the distances between the spiral turns of the clay shall be as small as possible.

4. He must also vary the pace of the wheel so that the centrifugal force may act differently under the varying conditions of the clay.

The chief defects in badly thrown ware may almost all be traced to ridges, more or less pronounced, running spirally from the bottom to the top of the piece. This at once shows inequality in pressure, and not only are they disagreeable to the eye, spoiling the appearance of the outline, but, what is of even more importance, the piece dries unequally and is almost sure to become distorted. The handles appear warped, and the covers, &c., will not fit, and sometimes even the piece itself will split. It will thus be seen that only round pieces can be made on the wheel, and that the ware is rarely finished by the thrower, but is handed on to the turner to be further shaped or polished. Thrown and turned ware is sometimes afterwards decorated by the application of figures, sprays, &c., made of clay from flat moulds and stuck on to the surface of the pieces with slip.

A few words on the decadence of throwing may not be amiss. In times gone by nearly all round hollow ware was made by throwers, and a really skilful man not only impressed originality on any artistic work he had to do, but could also when necessity arose produce with astonishing rapidity a large quantity of any article exactly to size. It is not wished by this statement to insinuate that there are no such men to be found to-day, as that would create quite a false impression, but during the last quarter of a century business in pottery all over the world has increased in volume owing to a general higher standard of living and a larger demand for comforts in daily life, and the demand for throwers exceeded the supply, as the number of good throwers was always limited, and it required a long apprenticeship to learn their art, and even then very few arrived at the

necessary degree of proficiency to undertake all classes of work.

The demand, then, for the thrower was great, as there was a certain class of work which could only be made with his assistance, and this gave him an exaggerated idea of his own importance and caused him to be exorbitant in his demands, irregular in his attendance, and indifferent as to the quality of his work. The largest trade being purely commercial, it became evident to manufacturers that some means had to be found to overcome this difficulty in order to produce the thousands of dozens of absolutely identical pieces that are required by trade; and it was clear that machine work was far better adapted to achieve this result than man's, as any individuality would really be a defect in pieces which were all required to be absolutely alike. The consequence has been the rapid introduction of machinery, and it was soon found that by a little thought and care in the arrangement of tools and moulds, there was not a piece of ware that the thrower made that could not be made off a machine, and as a rule made in such a way that even if it required turning the work for the turner was much facilitated, the form of the piece approximating that of the finished article much more than the piece formerly made by the thrower. To this end the potter and machinist directed their energies, with such entire success that there are few earthenware potteries, except those dedicated to artistic as opposed to commercial production, through whose doors a thrower ever passes. The result is that every day there is a less demand for throwers, and fewer serve their apprenticeship, and year by year the number will grow less, and this again constantly compels manufacturers to seek fresh methods of making any pieces still in the hands of the throwers.

That thrown and turned ware has many advantages must be at once admitted. It has less contraction, has a better appearance, and is stronger than machine-made ware, and if only a few pieces are wanted, the thrower can at once make them instead of the manufacturer having to go through the costly processes of modelling and mould-making; but much as the decadence of the thrower is to be regretted from the artistic point of view, it must be remembered that no trade can ever be dependent on the caprices of one class of workers, and it may be taken as an axiom that when any trade finds its development checked by the action of any one class of workers, that class, sooner or later, will almost totally disappear from the trade, some other method of doing their work being evolved to overcome the difficulty.

Apart from the thrower's independent attitude, the complexity of his counts and the constant demands for allowances on account of breakages by turners, etc., caused more friction and took up more time at the end of each working week than settling with any other ten men on the works. It is not intended to attribute the gradual extinction of the throwers solely to their own tactics, as the introduction of machinery was inevitable, but that by their action it was very much accelerated there can be but little doubt.

The ware, having been sufficiently dried, is handed on to the turner to be finished. It should be added that the ware must always be sufficiently moist for the excess clay to be turned off in shavings and not in dust, and for this reason, where much turned ware is produced, a cellar underground is necessary for the storage of any ware that cannot be turned and finished when it has attained the proper degree of dryness, as, should it remain above ground, it would soon become too dry, especially in hot weather. It may, however,

be preserved in good condition for a short time by covering it with damp cloths.

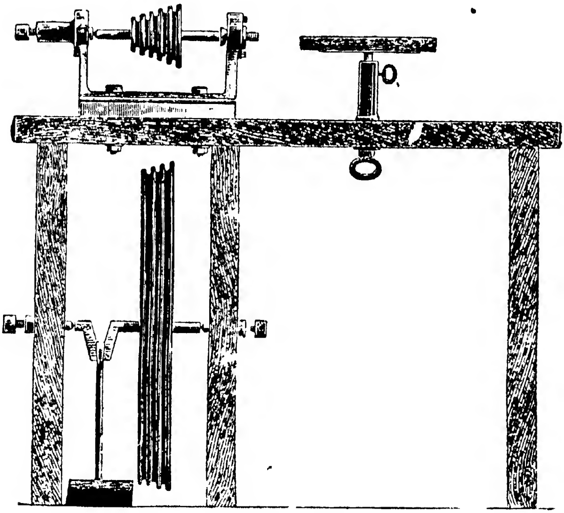
It is very necessary that ware should be in proper condition for turning; should it be too moist it will go crooked and out of shape, not having sufficient stability to resist the pressure of the tools; should it be too dry, it is almost certain to split either in fixing on to the chuck or during the operation of turning. There may be said to be two methods of turning.

The first, which is now almost solely applied to artistic pieces, on a vertical lathe, that is to say, the piece would stand in the same position on its base as when thrown. It is manifest that this is not an easy position for the turner to carry out his work, and so the majority of pieces are turned on a horizontal lathe similar to that used for metals, wood, or ivory. On this machine any piece may be brought accurately to any form whose section at right angles to its axis is a circle.

The lathe is of such general application and so well known that a few general remarks on its construction will be quite sufficient. The bed and supports of the lathe are either of iron or wood; the latter is probably preferable, as there is little strain in turning clay, and iron, being always liable to oxidize and thus discolour any clay in contact with it, is best avoided wherever possible. On the bed rest the poppet-heads, which are now generally made of cast iron; they fit accurately to the bed, and are held in position by a bolt screwing into a metal strip beneath the bed. The principal poppet-head has two standards, in one of which is fixed a conical bearing, in which one end of the mandril revolves, and by which it is supported, the other end resting against the hard conical point of a screw passing through the other standard. By this screw the mandril is kept tight up to its bearing, the tendency to shift

being obviated by one or two nuts screwed up tight to the standard.

The accurate running of this mandril is absolutely necessary for the production of truly circular pieces. A pulley with a series of graduated grooves is keyed on to the mandril, and this pulley is connected with the



THE LATHE.

driving-wheel, which is grooved in the same manner, by a cord, either of hemp, gutta-percha, or catgut. The latter is the best, and is generally joined by hooks and eyes. These hooks and eyes are made hollow at one end, and the ends of the gut can be damped, and then pressed and screwed firmly into them till they hold

securely. The object of the graduated grooves on the pulley and driving-wheel is to regulate the pace at which the mandril is to be driven. The supports on which the bed rests also carry the axle of the driving-wheel, which is counter-sunk at each end and supported by two conical screws passing through the supports. The motion is either given by a treadle attached to the crank on the axle and worked by an attendant, or by the modern system of steam, the pace being regulated at will by the turner by a system of cones and breaks.

At the end of the mandril, running through the standard of the poppet-head, a screw is cut, to which are attached the "chucks" or round pieces of wood on which, or in which, the clay articles to be turned are fixed. They are usually of a tapering form, which easily adapts itself to the inner surface of the vessel to be turned. A slide rest is required to support and guide the tool. This is usually a short hollow column provided with a foot which fits accurately to the lathe bed, and can be moved along it, being held in position when required by a clamp screw. Through the hollow column passes a "T"-shaped support, either of wood or iron, which can be lowered up or down through the column, and can be fixed at any height by a screw. Should the work be too long to be supported by the chuck alone, another movable poppet-head, with a clamping screw, can be moved along the bed to support the other end of the article to be turned.

The tools are of steel and iron, and are usually made of old files, saw blades, thin pieces of steel hooping, &c. They consist of shaving tools, polishing tools, profiles, cutting-off and edging tools, &c. The profiles are filed to the different shapes of the pieces required, or according to the different lines, ribs, or grooves which ornament the piece or form its foot, &c. The more profiles a turner

can use the better, as he is thus sure of having his pieces exactly alike in detail, and it enables him to get through much more work, as he merely presses the profile against the piece, and the work is at once cut to the form desired in less than half the time that would be occupied in turning it with an ordinary flat-edged tool. The tools are generally about 8 in. in length, and varying in breadth from a quarter of an inch to two inches, the cutting edge being turned up at nearly a right angle about half an inch from the end.

Old printers' knives, cut off and ground, make most excellent polishing tools. Turning approaches more to the work of the artist than to that of the workman, and the turner should have an accurate eye and a good idea of form, as for the most part the thrower or machine gives the thickness more or less, leaving it to a large extent to the turner to form and finish the piece. It is true that earthenware, being a very plastic body, can be thrown thinner and more nearly approaching the form required than would be the case with a "shorter" body, such as china, &c. Still, pieces which formerly were roughly finished by the thrower are now required with a finer surface and a more delicate finish, and so are passed through the hands of the turner.

The accurate and good filing of tools and profiles is of the highest importance in producing good turned ware, and the difference between good and bad turners is often as much in the way they have prepared their tools as in the way they use them. A special bench, apart from all clay-work, should be kept for filing, and no man should be allowed to do his filing anywhere else but at the bench provided for the purpose, and any man found using a file at his lathe or working bench should be reprimanded severely, and if found doing it again should be discharged; as, however careful a man may

be in filing, the small atoms of metal dust are carried in the air, and must settle down somewhere, either on the finished ware or amongst the scrap clay, and when the ware comes out of the ovens after firing it appears with brown specks on it from the fused iron filings. The damage caused by one careless man filing at his potting bench may be very great; and such an act should be looked upon as a very serious offence, and should not be lightly passed over.

It is best to have the files numbered and kept each in its place above the filing bench. One man should be held responsible for them, and should look over them daily to see that they are all there and in good condition. Should one be missed, he should at once find out who has removed it, and see that it is returned to its place. Some men have a perfect mania for files, and prefer filing in any place rather than in the appointed one. They are dangerous people to have about, and should be got rid of as soon as possible. It is not merely the fact of the ware being spoilt by the iron filings, but often it is impossible to be sure from what source the iron may have come, and much time and money may be spent in testing clays, magnets, and machinery, when the whole difficulty has been caused by the laziness or "cussedness" of one man who has touched up a tool with a file at his working bench instead of going to the right place to do it. The turner also requires a pair of compasses, callipers, and a gauge, as a great deal of modern work, such as electrical fittings, screws, patch-boxes, mugs, &c., have to be turned exactly to size.

Though many lathes are driven now by steam or other power, the advantage, economically, is not quite so apparent as in many other departments; as for celerity in working it is essential that the turner should have

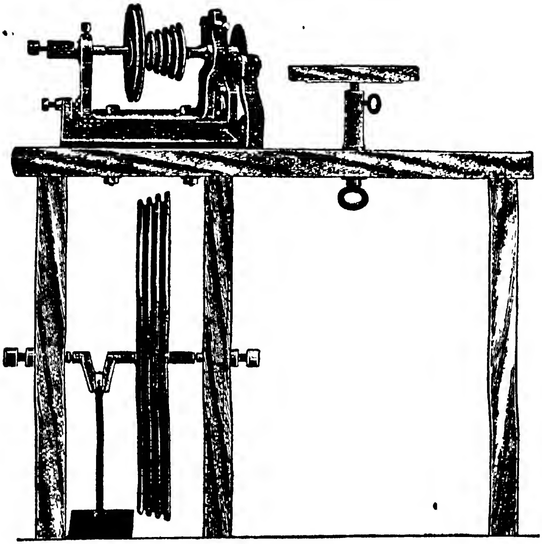
an attendant to hand him the pieces to be turned, and to receive them when finished. Small ware, such as thin cups, &c., are sometimes pressed a little out of shape, and the attendant should have a plaster cone on which he can press them to put them into perfect circular form again. There are also often small clay shavings sticking to the pieces, which must be removed.

The attendant can perform all these minor operations, and at the same time turn the lathe, as his time otherwise would not probably be fully occupied. And also, as he has to watch every movement of the turner to increase or decrease the pace as the work requires, or to reverse the motion as directed, he very soon obtains a good idea of turning, and when put down as an apprentice he already has a considerable insight into his trade.

The piece to be turned has then to be fixed to the chuck, either by its own moisture or by slightly damping the chuck with a sponge. Let us take a bowl as an example. The bowl is held in the left hand and placed on the chuck, the mandril revolving slowly away from the operator, when it is centred true, which is of course of the greatest importance; the edge of the bowl is pressed on the chuck by a round-ended tool till it is held firmly in position. To commence turning the piece the motion is reversed, the mandril revolving towards the turner. The tool is then applied to the piece, the fingers being steadied in position on the rest. In wood or metal turning, the tool itself would be steadied on the rest, as there is much greater resistance in the material being turned; but in clay-turning the fingers act as a buffer or spring, and thus breaking the more delicate substance is avoided.

When the bowl has been shaped to the requisite form and the foot cut out with the profile specially made for the purpose, the mandril is reversed, and the piece is

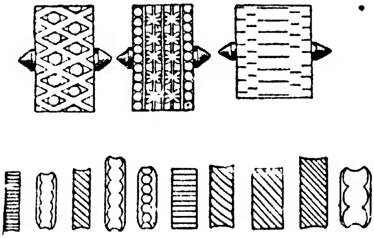
repassed with the polishing tool. This closes the pores, so to speak, and gives a finished appearance to the piece. Again the mandril is reversed, turning again towards the turner to enable him to cut the piece off from the chuck, which is done with a sharp cutting tool. It



DICING LATHE.

is safer when thus cutting off to support the piece with the left hand to prevent it jumping off the chuck, and the same precaution should also be taken when polishing. The edge is then formed with a tool filed like a sharp hook, and the piece, being finished, is removed from the chuck.

In rose, engine, and eccentric turning, the centre of the circle in which the work revolves is not a fixed point as in the ordinary lathe, but is made to oscillate with a slight motion while the work is revolving upon it, the tool remaining fixed, so that the figure will be "out of the round", or deviate from the circular figure as much and as often as motion is applied to the centre, and by a system of rosettes of different sizes, coupled with the action of a strong spring to restore the mandril to a central or vertical position when disturbed therefrom by an indentation of the rose.



Embossed Rollets.

The mandril may contain different rosettes to vary the pattern as it proceeds. In what is called the "pumping movement" of the rose lathe the mandril is made to move endways on its bearings. By this motion waved lines can be [illegible] upon a cylinder in the direction of its length. Many patterns are obtained on the lathe by the use of elliptical or oval chucks and by overhead motions. Dicing and milling are also often applied to pottery, and a great number of very complicated geometrical patterns can be obtained when the work revolves on the lathe and the eccentric cutter is driven by a band in connection with the mandril.

Of course these latter applications of the lathe are quite outside the ordinary work expected from it, and in fact could only be successful in the hands of really scientific turners. A good deal of ordinary decoration is obtained by the use of rollets or rowels pressed against the work as it revolves, and they will be found to work best when oiled with a little turpentine.

Turning is one of the most interesting parts of the manufacture, and is daily becoming of more importance owing to the large demand for scientific and electric fittings, which have to be made with the greatest exactitude. As in other parts of the manufacture, there is a great difference between good and bad work. There is one thing, however, to be said, and that is, bad work in turning is impossible to hide. If sizes or shapes are wrong, they are at once perceived, but it is more difficult to detect "wreaths" which are caused by moving the tool unevenly and irregularly along the piece After it has been repassed with the polisher, these wreaths disappear; only, however, to reappear after the firing, no matter how carefully the polishing has been done. If it costs no more to put a piece of ware on the lathe than to have it fettled by the jiggerer or presser, it is always advisable to turn it.

There is less loss in the ovens with turned ware; it is stronger; it has a better appearance when glazed, and requires less material to glaze it, probably owing to its being not quite so porous, the pores having been partially closed in polishing. Its surface is smoother, and its finished appearance is undoubtedly superior; so that if the cost of labour be equal commercially, a better article can be offered at the same price.

CHAPTER VII.

PRESSING, CASTING, HANDLING, AND STICKING-UP.

PRESSING is the term applied to the method of making articles by pressing clay on or into moulds in such a manner that it receives the form of the mould, and therefore the piece, when extracted from the mould, is a facsimile in detail of the model from which the mould was originally made, except that, owing to the contraction of the clay in drying, it will be smaller in size.

The presser requires a bench on which to work, a plaster block, some 2 ft. 8 in. square, though the size would depend much on the class of work he has to make, usually made on a brick foundation which offers more solidity and strength than if merely placed on the bench; a plaster-headed whirler which revolves in a socket fixed to one of the uprights of the bench. He also requires a drying stove or room surrounded with shelves or pegs for boards on which he can put his ware to dry.

These rooms are heated either in the old-fashioned style with fuel in iron pot-stoves, or in the modern manner by steam pipes heated by the exhaust steam from the engine, which is more economical and far cleaner, as there is no coal, coke, or ashes carried in and out of the shop. The heat is also more regular, as the pipes can be run all round the room, whereas the pot-stove would probably be in the centre, and the pieces near it are liable to get dried unevenly, more on the side nearest the stove than on the other, which would be likely to cause cracked or distorted ware.

The presser's tools consist of a batter, which is a round plaster block with a handle fixed across it, used to beat and flatten out the clay; a wooden roller like a rolling-pin is sometimes used for the same purpose. A piece of brass wire to cut up the clay in case he may wish to wedge it before using; sponges of different sizes—coarse for bossing in the clay, fine for cleaning off and finishing the ware—sticks with sponges attached to them, for pieces whose orifices are too small to allow of the admission of the hand. Pieces of horn, which should be kept in water to render them soft and pliable, and which are used for putting a smooth surface on the ware; pieces of india-rubber or leather for the same purposes, or what some workmen prefer to either of these, a cow's lip, a trimming knife; punches of different sizes for cutting out the holes in grids and trays; a strap to hold the parts of the moulds together while working; a basin or jar of water; and another small one for slip.

These are his requirements for ordinary work, though for special pieces other things may be necessary, such as pencils for slip, cloths or leathers on which very large thin bats may be made and lifted up without breaking, &c., &c The quality of sponges is very important to the presser, and should the work be required extra well finished he must use first-rate sponges of the finest texture.

The presser makes the greater part of the ware that cannot be made on the machines, that is to say, pieces that are not round, or for other reasons are not suitable for machine work; he would also make pieces of which only a small quantity are required, and therefore are not worth while arranging for machine production. For instance, ewers, oval or square, soup-tureens, sauce-boats, jugs of certain shapes, brush-trays, square soap-trays,

square sugar-boxes, and tea-pots, pickles, &c., would be allotted to him. It is clearly impossible to describe the detail of the manufacture of every piece mentioned, and it is therefore proposed to select the ewer as an example and describe the method of its production.

The ewer-mould is made in three parts, closely fitting together and held in position by the natches, as has already been described. The body is made in two halves, divided from top to bottom, at the front and back. The bottom fits tightly to the body when the two half-moulds are placed upon it, being kept also in position by the natches.

The presser first places the two half-moulds separately on his bench, and then takes a lump of clay which is usually rather drier than that required for machine work, and places it on the plaster block. This block should always be kept moist, and if it has not been used for some time, a small ridge or wall of clay can be placed round the edge and filled up with water and left for twenty-four hours; it will thus become thoroughly moist and ready for use. If dry, it would suck up too much moisture from the clay when batting out. He then cuts the lump of clay in half and dashes it down on the other half; this action he repeats several times, and it is called wedging. This operation is not absolutely necessary when the clay has been pugged, but pressers often put the clay aside to get rather drier and harder than when it comes straight from the pug, and it may then require to be wedged to bring it all through back to the same degree of moisture, as the outside would have become drier than the interior.

He now cuts off a piece of clay the size he requires and proceeds to bat it out with his batter on the plaster block into a smooth bat or layer of clay of the thickness necessary for the article he is about to make. This bat

of clay is then carefully laid on the half of the mould, the face made by the batter being placed in contact with the mould, and thoroughly bossed in with a sponge. Should there be a pattern in relief on the ewer, it will require more bossing than a plain piece in order to impress the clay thoroughly into all the crevices of the pattern. Another bat is then prepared for the other half of the mould and the same process gone through again with it. As a matter of fact, the presser would probably bat out a considerable number of bats before commencing the work of applying them to the moulds, as he would thus save time. It may here be mentioned that several machines have been invented for batting out large bats, which have been more or less successful, but they have not up to the present come into very general use.

The two halves of the mould being lined with clay, the edges are trimmed, and they are then joined together and held firmly by a strap passed round them. Any clay overlapping the edges of the half-moulds should be cut off by running the thumb down the edge, and care should be taken that no clay gets between the edges of the two half-moulds, or they would not fit closely together, and the seam or join, when finished, would be large, and therefore unsightly. They are placed on the whirler, and the presser can thus turn them round easily, which offers greater facility for working. He then makes two thin rolls of clay and lays them along the seams formed by the junction of the two half-moulds, and by the aid of his fingers and a sponge incorporates them with the clay till the two halves are thoroughly joined together and the internal surface quite smooth. In a piece of this size there is little difficulty in effecting this, as there is ample room for the admission of the hands at both ends.

The bottom mould is now placed on the bench, and a clay bat pressed on to it; a small roll of clay is then arranged round it to make the joint with the sides. The two half-moulds are then placed on it, and the seams are thoroughly worked together from the inside. The whole interior is then smoothed over with a fine sponge and clean water, or with a leather, care being taken to avoid making marks with the sponge and to leave the interior as smooth as possible. The mould is then placed in the drying stove till the piece is sufficiently dry to come out of the mould. As it dries it also contracts, and so it delivers easily.

Meanwhile the presser makes another somewhat larger roll of clay and carefully arranges it in one half of the handle-mould, places the other half on the top of it, and applies the whole weight of his body to it for a few seconds till the two parts are pressed closely together. After drying for a short time the mould is opened and the handle taken out, the seam is trimmed off with the knife and any other little roughnesses there may be are cleaned off with a fine sponge.

We will now suppose the body of the ewer sufficiently dry to be extracted from the mould, and it is of great importance that it should be neither too dry nor too wet; in the former case the handle would not stick properly to the body, and though apparently firmly on before going into the oven, it would, after firing, probably be found cracked and defective. In the latter case, in sticking on the handle, the body, not having sufficient stability, would be pushed out of shape, and pieces once put out of shape when partially dried, although pressed back into their proper shape before going into the oven, are exceedingly likely to become crooked again during the firing. It is in fact highly necessary that all parts or pieces that have to be joined

together should be in the same state of humidity or dryness.

The ewer is then taken out from the mould, looked over, the seams fettled and cleaned off with a knife and touched up with a sponge or horn. The ends of the handle are cut at an angle to exactly fit on to the body, and both the ends of the handle and the point where the handle fits the body being roughed or scatched in order to make a firm joint, they are stuck together with a little slip The point at which the handle is to be fixed is generally marked in the mould; sometimes part of the handle itself being formed in the body-mould, so that the handles may all be put on at the same height and in the same position. Great care must be taken that the handles are stuck on both upright and straight—a crookedly-handled piece is most unsightly.

Some pressers like to use ball clay slip, as it seems to be more adhesive; but it is rather dangerous in practice, as, being of a slightly different colour from the body, it may leave discolorations on the piece where the handle is joined on, so that for general use the ordinary body slip is the safer. After the handle is stuck on and the joints carefully cleaned, the piece is put back to be thoroughly dried before going into the oven. When quite dry and in the white state, it can be looked over again, and any small imperfections can be rubbed down with a piece of flannel or cloth.

A presser will require for continuous work a varying number of moulds, according to the size of the piece and the time taken in manufacturing it. That is to say, should he only be making one article, he will want sufficient moulds so that when he has filled them the piece of ware in the first mould he filled will have had sufficient time to dry, and will be ready to come out.

It will also naturally depend on the drying facilities given and the heat kept up in the stove.

Ware is generally dried on boards, or on plaster bats; but if very large pieces with wide mouths have to be dried mouth downwards it is better to make clay bats at the same time as the piece, and dry them on these—the clay bat, drying at the same time as the piece contracts equally with it. A piece of this description, if dried on a plaster bat or board, would contract, and the board or bat, remaining rigid, would not give, and the piece would split almost to a certainty.

It is evident that for facility in work men should be kept as much as possible at the same class of work during the day, and it is better to have one man making ewers one day and sauce-boats or what not the next, rather than making some of one and some of the other. To carry this out more moulds are necessary, but the work is better and the man can do more, and probably make better wages working at a lower price than if he had to turn from one article to another. This is only stated as a general rule, as there are many articles of the same class which work in very well together. It is very necessary in pressing to make the piece as nearly as may be of the same thickness all over. Pieces that are thick and thin in different parts are very likely to crack in firing, owing to the variation in contraction. A good presser must therefore work systematically, and apply an equal pressure over all his work, as apart from the difference in contraction, unequal pressure will often cause an irregular surface most detrimental to the appearance of the article.

After a considerable time moulds lose their absorbing power and the ware begins to stick slightly to them. This is caused for the most part by long exposure to the atmosphere of the shops, the pores of the plaster

being stopped up by the floating dust and dirt. The same defect may also result from much use, an exceedingly thin, firmly pressed film of clay forming a sort of skin over the mould. This can be removed by carefully scraping and sand-papering the surface, but the operation cannot be often repeated, as it alters the size of the mould. The same object may sometimes be attained by well scrubbing the mould with a brush and water. A mould that has absorbed all the water possible is likely to present the same difficulty, and therefore for fast work a considerable number of moulds are required to give them the necessary time to dry between the operations of filling them with clay.

Casting.—There are many pieces that cannot be pressed, on account of their excessive thinness, or owing to their shape not permitting the presser to manipulate the clay in them and work it thoroughly into all the cavities of the mould. To make either of these classes of pieces the clay is introduced in a liquid or slip state into the moulds, and by capillary attraction a film of clay is formed on the plaster in contact with the liquid; the thickness will depend on the time the moist clay is allowed to remain in the mould, the massiveness and absorbing power of the mould, and the nature and substance of the slip. The slip should be carefully lawned to free it completely from any granular particles of harder clay, and it should be gently stirred to allow any air-bubbles that may be in it to escape. The moulds are usually in several parts, the number depending on the form and elaboration of the article required; they are tied firmly together, and the liquid clay is poured into the hole left in the mould for the purpose. As the plaster absorbs the water, leaving the clay film on the sides, more slip is poured in, till the potter thinks a sufficiently thick coating has been formed on the mould;

he then pours out the superfluous slip and puts the piece to dry.

The slip should be of a fairly plastic nature, and to increase this quality a rather larger proportion of "scraps" may be added for making the body than would be used for ordinary purposes. Very plastic clay will, however, at once form a crust over the mould, forming an almost impermeable coating, thus preventing the plaster absorbing any further moisture. After a short time the clay begins to harden and contract, and it should then be removed from the mould. This is a delicate operation with very thin pieces, and great care is required to remove them from the mould without damage.

Casting is more generally applied to china, where great thinness and delicacy are required, than to earthenware; yet there are many pieces in earthenware manufacture, such as tea- and coffee-pot spouts, tubes, &c., which can only be satisfactorily made by this process It is perhaps a slightly cheaper method of manufacture than pressing, but causes great destruction to moulds, especially if the workmen introduce a little salt or soda into the slip to make the moulds "deliver" more quickly; this, of course, should not be allowed. It also has the advantage of giving a more uniform thickness to the piece and a very clear impression of the mould, and so is useful for pieces of elaborate detail, and its contraction being the same all over, ware made by this process is not so likely to split in the firing. The clay not being subject to pressure, and the water being absorbed by the mould and evaporated, the body is really left very porous, and cast ware is therefore more liable to the defect of crazing than ware made by other processes.

Cups, cup-handles, tubes, pillars, spouts, pieces both

large and small, may be made by casting, but slightly different applications of the process have to be adopted in accordance with the shape of the piece in order to obtain good results. For instance, in tall pieces like pillars it is best to introduce the slip from below and allow it to rise to the top of the mould, to avoid any chance of air-bubbles, which in drying would leave little holes. This is done by connecting a tube from a reservoir containing the slip with the bottom of the mould. It should, however, be noted that in this method the vessel containing the slip must be placed considerably higher than the mould it is intended to fill, as the liquid slip, on account of its sticky and glutinous state, will not rise to the same height in the mould as it is in the reservoir.

The great drawbacks to casting are the excessive contraction of the pieces, being with some bodies as much as 25 per cent, and the large number of moulds required. Its chief advantages are: the lightness obtained, and its adaptability to pieces of unusual shape and of elaborate ornamentation. Cast pieces are rarely free from blemishes on being removed from the moulds, and always require looking over and retouching. In making models for cast ware, especially figures, it is necessary to make provision to counteract the inequality in contraction, and to bring the contraction to a common centre.

Handling, as its name implies, is the making and fixing of handles to the pieces already made. But, apart from fixing handles, there are often other parts that the handler has to adjust, such as spouts to teapots, snips to jugs; in fact, he often carries out in the smaller articles the same work as the "sticker-up" does in large. Handles are usually made in two ways: either out of plaster moulds when of an ornamental and elaborate

character, or from a "wad" or squeezing-box when of a simpler form.

The wad-box is merely a hollow iron cylinder in which works a screw plunger fitting accurately and held in position in an iron frame on the working bench. When the screw is raised the cylinder can be removed for the greater facility of filling it with clay. There is an aperture in the bottom of the cylinder, and over this aperture is fixed a movable metal plate in which is cut a hole in the form of the section of the handle it is desired to make. The cylinder is then filled with a solid lump of moist clay well pressed into it. A piece of old cord is laid round the edge and covered with a flat iron ring, thus forming a washer, and preventing the clay from escaping between the plunger and the side of the cylinder when pressure is applied. It is then placed in position under the screw plunger. The plunger, on being depressed, forces the clay through the hole in long strips in the form and thickness required, reproducing the flutes or ridges cut out in the metal plate. These strips are received on a slanting board, and are cut off by the handler in lengths suitable to the work in hand.

Care must be taken not to twist or deform the clay strip as it issues from the wad-box, as this deformation would probably be reproduced in the firing. The pieces are then bent into the necessary shape, trimmed off at the ends, and affixed with a little slip to the article to be handled. Sometimes each end is ornamented with a leaf or shell, by pressing it with the thumb into a small plaster mould containing the necessary design. This class of handle is called a "Dod" handle, and is usually employed on the cheaper classes of ware, such as mugs, chambers, and barrel jugs.

In making handles from moulds the wad-box is also

requisitioned to make the little rolls of clay required for filling the moulds. Instead of the metal plate at the bottom of the wad-box, a thicker plate, often of iron, filled with round holes, is substituted, and the clay is squeezed out in little rolls. They are cut into suitable lengths, and placed in one half of the mould; the other half is then fitted on, and the handler's boy leans his full weight on it for a second or two, and then proceeds to fill the next mould in like manner. He generally requires about half a dozen moulds, and by the time the last one is filled the handle in the first one is ready to come out.

The handler usually employs several attendants to make and trim the handles and clean the ware after it has been handled, he, as a rule, doing the actual sticking on himself. Any work of special difficulty, such as handles that require very accurate cutting, &c., and fitting on account of the shape of the piece, he would also do himself.

Each handle as it is taken out in turn from the mould is laid on a board, and when they are sufficiently dry the superfluous clay is removed, and they are trimmed and fettled and sponged if necessary, and they should be cut at an angle exactly to fit the body to which they are to be applied; this is very important in order to make a good joint. In removing the handles from the moulds they should not be strained or bent, or the defect will very likely appear after firing. Cup handles when taken from the moulds are not unlike the human ear, owing to the extra clay being squeezed out round them.

Handles made from moulds are the most general now in use, as they are more elaborate and decorative in appearance. The remarks as to the condition of ware in the note on "sticking-up" apply equally to handling, and the body and handles should be of the same clay

mixture, and should be as near as may be in the same state of humidity to ensure the handles being firmly fixed on, and to avoid cracks. Should the ware and handles be too dry, they so readily absorb the water in the slip that the handles will not stick on, and it is then necessary to add a small quantity of gum water to the slip, which will hold the parts together till the firing. But it is far more satisfactory to have the ware in the proper state, and so if there is more ware than can be handled it must be sent down to the cellar, as in the case of ware to be turned, or covered with damp cloths.

After handling, all superfluous slip must be cleared away from the joints, and in the case of cups they should be gently pressed on a plaster cone to ensure them being quite round, as the handler may have put them slightly out of shape in applying the handle. It is better that cups should be "boxed" ready for placing—that is, one cup is placed on the other edge to edge, one handle being exactly over the other. They should be just moistened at the edges with thin starch, and they will then stick together. By treating them in this manner the loss from crooked cups in the ovens is much less.

Handling requires considerable experience, as for the most part the pieces have been turned or machine-made, and as the handles are pressed in moulds they have not been made by the same process as the bodies, and, therefore, the contraction is probably slightly different, and the joints are more likely to crack, and the handles, being the lightest part, are more likely to distort. In fact, in some cases with certain shaped handles that have to be applied to turned cups, the handles are put on slightly out of the straight, so that the contraction will draw them back again during the firing. Experience

alone can allow for this, and shapes requiring so much attention should be avoided.

It is important that handles should be comfortable to hold, and pleasing to the eye, and also that they should have sufficient surface at the point of contact to stick firmly to the piece. They should also not project too far from the body, as they take up more room in the ovens, and are very likely to be broken off during the various processes they have afterwards to go through. The difference in loss between a well-designed and badly-designed handle is enormous.

The chief defects in handling are from crookedly placed handles, or handles placed too high or too low, or when there are two handles, placing them at different heights on the different sides. These defects are clearly due to carelessness, or from cracks, which are almost invariably caused by the handles or pieces, or both, being in an unsuitable condition, or to an improper use of slip, or by the handle not being properly adjusted to the piece, so that the slip is thick in one place and thin in another. The same remarks apply to jug snips, spouts, &c , &c.

Sticking-up should, perhaps, not be mentioned till after the making of ware on the machines has been described, but as it is so closely allied to pressing and handling it is considered best to refer to it in this chapter. Owing to the introduction of machinery, round pieces, such as soup-tureens, cover-dishes, soap-dishes, sponge-trays and grids, salads, &c., which were formerly made by the pressers, are now jollied on the machines.

It is clear that to get full value from a machine it must be constantly running. It is therefore best to keep a man working at the machine continuously, making the bodies, covers, feet. &c., and then to send on the unfinished pieces to the pressers or handlers or to special

men to "stick up" and fettle as this is work which could not be left to the jiggerer's apprentices; that is to say, they stick the feet to the soup-tureens, make the small handles from moulds for the bodies, knobs for the covers, &c., and stick them on, cut out the snips for the ladle, and finish them in every detail. In the same manner compotes are made in three parts on the machines, and are afterwards stuck together. Any pieces that have thin feet, like soup-tureens or compotes, should be put to dry on plaster bats, and not on boards, as should the latter not be quite level the feet will go crooked and the piece rock.

By dividing the processes (which is the tendency in all modern manufactures) each man gets more expert in executing his own particular detail with exactitude and celerity, and it is evident that it would never pay to have machinery running and the man who should be producing ware off the machine spending half his time fettling and sticking up work. The machines would then be idle and their producing power lost, and most probably the motor power would have to run for other purposes all the same, to say nothing of the interest on capital for the machinery standing still. No doubt, by this system of division of labour a man is not so thoroughly a master of his trade as formerly; but owing to the modern competition in cheapness every means of reducing cost has to be studied in the production of every-day articles.

The chief point to be observed in sticking up ware is that all parts should be of the same degree of moisture. They must be accurately trimmed to join exactly, and it is always better to cut the parts obliquely when possible, as they thus have a wider surface to stick together. The joints should be fitted together quickly, and with accuracy, and when once put together they

should not afterwards be moved. Sufficient slip must be used to stick them firmly together, but not enough to form a separate layer between the two pieces, or they are exceedingly likely to come apart or crack during the firing.

Dish-making.—Before proceeding to any remarks on machinery, it will be as well to refer to dish-making. Dishes have for some time past been manufactured with more or less success in different countries by machinery, but for various reasons the system has not been generally adopted. Machines to produce oval forms of ever-varying shapes and sizes must necessarily be complicated, owing to the variety of eccentric motions that they necessitate, and no doubt this reason alone, without searching further, has been the chief obstacle to their general introduction. The majority of dishes to-day are therefore still made by hand.

The dish-maker bats out the clay bats on a plaster block with a batter, and then with a long flexible knife puts a perfectly smooth face on the bat. This face is then applied to the dish mould and carefully pressed on to it, and thus forms the surface of the dish. The mould is then, for facility in working, placed on the whirler and the dish smoothed carefully with pieces of pitcher, horn, and fine sponge to form the back of it. Should a foot be required it is either made with a pitcher profile which has been previously made and fired in the oven, or should a higher foot be required than can conveniently be made by this means a foot is made out of another mould and stuck to the dish.

A dish-maker requires considerable stove-room, as after the dishes have been dried sufficiently to come off the moulds on which they have been made they are fettled and then placed face downwards—"warved" as it is called—on plaster slabs, which have had the surfaces

ground perfectly true, so that they may dry perfectly straight and not go crooked. They should be left on the slabs till white dry, especially in the case of the larger sizes. Dish-making requires considerable skill, and very large dishes are exceedingly difficult to make satisfactorily, as they require an absolute even pressure all over when making them, or distortion will result.

CHAPTER VIII.

THE APPLICATION OF MACHINERY TO POTTING.

The modern tendency in all manufactures is to utilize machinery as much as possible, and earthenware manufacture is no exception to the rule. In fact, during the last twenty years there has been quite a revolution in the method of manufacture of almost every class of earthenware, and fresh applications of machinery are daily being introduced. The articles required for daily consumption have to be turned out in such enormous quantities and so absolutely identical in size, thickness, and shape, that machinery is eminently adapted to their production. Cups, saucers, plates, chambers, basins, salads, cover-dishes, soup-tureens, jugs, &c., in fact any circular article can be made with the aid of machinery.

Modern mechanics have arrived to such perfection that machinery can be designed to do any class of work; but there always remains the difficulty of making machinery so simple that there is small chance of it getting out of order, and that the working of it requires little or no mechanical knowledge. It is only intended here to give a rough sketch of some of the machines to facilitate the explanation of the manufacture of ware on them. To give full details and descriptions would necessitate drawings to scale, and far more space than the scope of these notes would allow.

The machinery for potting is made by potters' engineers, who dedicate themselves almost entirely to this class of work, and probably the modern potter who uses machinery is indebted to no one more than to Mr. William Boulton, of Burslem, and Mr. Faure, of

Limoges, to whose skill and versatility so many of the machines and applications of machinery owe their origin.

Steam or water usually supply the motor power, and the heavy slip-house machinery and mills are driven direct by shafting; but for the lighter running machines for the actual production of ware the power is transmitted by endless ropes, either driven directly from the engine or from a shafting connected with it by belting, which can be thrown in or out of gear and run or not as desired. The rope passes round the different shops supported on small V-grooved pulleys, and running under the benches where the machines are placed and driving them on its way. The rope runs continuously, but the machines are so arranged that they only run at the will of the operator.

At each machine there is a wheel fixed to a lever, and the workman, pressing against this lever with his leg, pushes the wheel against the rope; this deflects the rope and presses it against the driving-wheel on the spindle of the machine, and thus conveys the motion to it. When the lever is released the rope goes back to its original position, running just clear of the driving-wheel of the machine, and the machine stops. The pressure of the lever wheel throws the rope a little out of the straight line, and therefore, so to speak, shortens it and increases the tension. If all the machines on a rope were running at once this would considerably increase the strain, the rope being slightly shortened at each machine, and the result would be continual breakages. To obviate this, the rope is passed over two pulleys close together, and a third pulley with a heavy weight attached to it is hung on the rope between the two fixed pulleys, the distance between these being the diameter of the weighted pulley. The weight being

arranged in a grooved frame, slides up and down as the tension increases or decreases. The weight always keeps the rope at the proper tension for the work, and thus acts as a sort of safety valve.

When a machine is started the rope requires a little more length and so pulls up the weight a little; when the machine stops the rope goes back to its original position; the weight at once descends and pulls in the slack rope. As the rope is an endless one, the farthest point to which it is carried is the point at which the "outrunning" rope ceases and the "incoming" rope begins. It is evident that as the engine is pulling or winding in the rope the "pull" will be on the incoming or upper rope as it passes over the driving-wheel, and the outgoing or lower rope will be rather slacker. The safety-weight is therefore fixed a short distance from the driving-wheel, some 20 to 40 ft. away on the outgoing rope, to take up the slack and keep the tension equal. The weight frame should be about 8 or 10 ft. high, so that as the rope stretches there is room for the weight to descend, as once the weight reaches the bottom it ceases to act and the rope must be shortened and respliced. The grooves in which the weight runs should be kept clean and well-oiled, as it is incessantly moving up and down and should work with the least possible friction. The pull being on the incoming rope, it is evident that machines will run better on it than on the outgoing rope.

The finest cotton rope is used in preference to hemp, as it is more pliable and longer in the thread and therefore less liable to break. The ends require carefully splicing, and the splices should be tapered as much as possible so as to cause no sudden increase in the diameter of the rope, to ensure level running and to avoid any liability of the rope to jump off the pulleys. The

breaking of a rope is always to be avoided, as it stops all the machines running on it, and it will take from half an hour to an hour at least to resplice. It should therefore be looked over from time to time, and any weak part should be cut out and a new piece spliced in to replace it. A new rope always stretches considerably, and after a day or two's running it will be necessary to cut out a piece and resplice it.

When splicing a rope, either new or old, the safety weight should be pulled up to the top of the frame and fixed there to shorten the rope as much as possible; one end of the rope should then be made fast and the other should be pulled as tight as possible, care being taken that it is on all its pulleys; the point should then be marked on the rope where the joint should be, and the splice is carefully made. The splice can be made at the exact point measured, as there is little chance of pulling the rope too tight, especially if it is a long one, and it will soon stretch sufficiently to give the weight proper play. To conduce to smooth running the rope should from time to time be waxed; this is best done by holding a piece of bees-wax against it when in motion. A little, however, may be specially rubbed on the splices, which prevents them fraying out. After a rope has been running some time it becomes black, and has more the appearance of india-rubber than of anything else.

The pulleys that carry the ropes are V-shaped in order to get a good hold of the rope. They should run absolutely freely on hollow axles and will require oiling two or three times a day, and a thorough cleaning every now and then. They should make no noise except a slight humming as the rope runs. Great care must be taken in fixing the pulleys in such a manner as to avoid friction, that is to say, in an exact straight line from the centre of the groove in one pulley to the centre

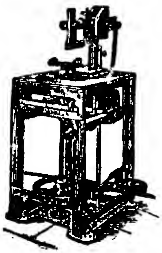
of the groove in the next, so that the rope does not pull against the flanges of the pulleys. If this rule is observed a rope can be turned almost anywhere, but in a contrary case it becomes a fruitful source of breakages. Ropes, with proper care, will last three years or more, though this is rather an exceptional time; and the longer the rope the more breakdowns will there be and the shorter time will it last. It is useful to keep in the shop a long stick with a grooved roller off the top, so that if the rope jumps off a pulley it can at once be put back in its place.

When the pace most suitable to the machines has been decided on it is best to always keep the engine as nearly as possible going the same number of revolutions, as it is awkward for the men having their machine running at one time fast and at another time slow. A good pace for a rope would be about thirteen or fourteen miles an hour. The great advantage of a rope is that it can be carried round corners, up and down, in fact almost anywhere as long as strict attention is paid to the position of the pulleys. No doubt in the near future electricity will become general for the running of all light machinery, but meanwhile a properly arranged rope is by no means to be despised.

The first object in all the machines here referred to is the same, that is, to obtain rotary motion. The simplest and most general form is that of a spindle working in a socket at the bottom and running absolutely truly in a collaring at the top; to this spindle is keyed a V-grooved wheel which is driven by the running rope when pressed against it. On the top of the spindle which rises through the bench, a screw is cut to which can be fixed the heads, &c., that have to be set in motion.

Batting Machine.—The first machine that claims our attention is the automatic batting machine, as this is

necessary for rapid production both in the making of flat and hollow ware. It has then a revolving spindle as above described, to which is affixed a round plaster block about $2\frac{1}{2}$ to 3 in. thick and varying in size from a diameter of 1 to 2 ft. in accordance with the size of the bat to be made. This plaster block is cast on a claw-shaped piece of iron firmly embedded in the plaster, which is screwed on to the spindle. The plaster block is then turned level and true while revolving on its spindle. Behind the spindle is an iron upright fixed to the bench or cast on to the bed of the machine, to which is attached an arm working up and down on a pivot. One end of the arm projects over the centre of the plaster block, and to this end is fixed, by nuts and screws, the tool or spreader.



BATTING MACHINE.

The tool consists of a flat piece of iron about $\frac{1}{2}$ in. thick, bevelled away on the right-hand side, with a hole cut in the upper part of it for the screw to pass through to bolt it to the arm. It is set with one end exactly over the centre of the plaster block, its length being governed by the size of the bat it is desired to make. The other end of the arm behind the upright is connected by an iron rod passing through the bench, with a lever attached to a cog-wheel which is set in motion by a screw on the spindle working in it. The spindle being set in motion starts the cog-wheel, which pushes up the lever and the arm, and thus depresses the tool towards the plaster block.

The tool can be set to descend on to the plaster block or to stop at any intermediate point above it; and the distance between its lowest point of descent and

the plaster block will be the thickness of the bat of clay. The mode of operation is as follows:

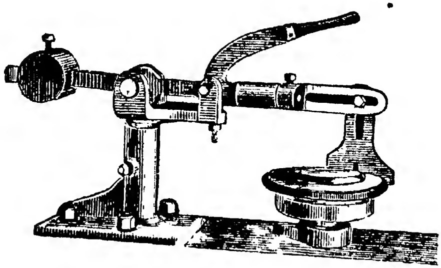
The workman places a lump of clay in the centre of the plaster block and then starts the machine by pressing the lever which pulls back the spring brake, and at the same time pushes the endless running rope against the driving-wheel As the spindle revolves it sets in motion the cog-wheel and the arm depresses the tool on to the lump of clay revolving on the plaster block. As the tool descends it spreads the clay out in a circular bat to the thickness which has been arranged in setting the tool. When it reaches the lowest point at which it has been set the lever is automatically released, the rope returns to its original position, the spring-brake comes into action, and the machine stops, the tool at the same time rising back to its former position.

Formerly the plate-maker would have had to beat out every clay bat on a plaster block with a batter, which, apart from the time taken up, was an operation of considerable labour; whereas, now he, or one of his apprentices, merely puts a lump of clay on the plaster head, starts the machine, and the work is done. He may, perhaps, as he starts the lever, just moisten his fingers in water and touch the top of the lump of clay, as it puts a smooth surface on the bat should the clay be a little dry.

Plate-Machines or *Jolleys*, as their name implies, are for making plates, though saucers and small hollow ware, such as bowls, with a proper arrangement of tools may also be made on them. The modern machines have a frame and bed of cast-iron, and when in position are of the same height and form part of the bench in the shop. They have then a spindle which is driven as already described. The top of the spindle has a screw

cut on it to which can be adjusted the various heads, into which the moulds fit, and which are usually made of iron. These heads must fit on to the spindle perfectly and run absolutely true. They require very nice adjustment and, however carefully made, new heads will generally want a touch or two with a file where they connect with the spindle before they run to perfection. The interior of the head must also have been trued absolutely to the centre on a lathe.

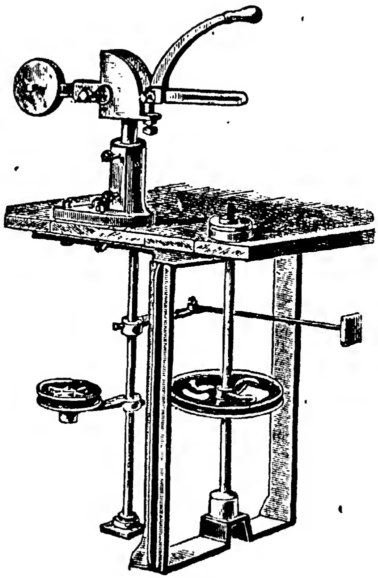
Heads should be interchanged as little as possible but be reserved for their own machines. Some machines



HEAD OF PLATE-MAKING MACHINE.

will require several heads, as work of varying size is produced off them. Spare heads can be made of plaster with a lead collar run inside them which can be turned true on the machine on which they are to run. All heads should be carefully cleaned and oiled at each week-end and unscrewed carefully from the spindles, and the screws of the spindles should also be oiled and covered with an inverted bowl to prevent any dust getting into the screw or bearing. If the heads are not taken off regularly they are liable to become fast and

can then only be got off with difficulty, and in applying the force necessary to unscrew them the spindle may be bent out of its true centre. The head then runs true on the spindle, to which motion can be given by the endless rope. The mould is now placed in the head



JOLLEY.

and fits in with a bevelled natch, as already described under mould-making, and should therefore also run perfectly true. It can easily be tested by holding a pencil-point over the mould and making a small circle at the centre. Behind the spindle, and attached to the

bench or bed of the machine, is an upright iron support, working in a socket and held firmly at the height required by a set pin. To this support is fixed an arm and handle, swinging up and down on a pivot, but with no lateral movement. It can be pulled down till it is about horizontal, when it is stopped from descending further by a screw passing through the support from below, in front of the pivot. This screw can be screwed up or down, allowing the arm to descend a little farther, or not quite so far, as may be desired; this is useful sometimes in tool-setting. To this arm are fixed the tool-holders. They fit quite accurately into a square socket and are firmly held by a set pin.

The sockets should be kept quite clean, so that the holder, when introduced, always fits into identically the same position. The tool-holder is about $1\frac{1}{2}$ in. broad and is pierced in nearly its whole length (about 3 in.) by a hole about $\frac{1}{2}$ in. wide, so that the tools can be fixed to it in almost any position with a screw and nut, and are held down to the work by the handle attached to the arm. At the other end of the arm, behind the upright, is a counter weight which rather more than balances the weight of the tool-holder and tool, so that the tool always swings up out of work when released from the workman's hand.

In flat work, such as plates and saucers, the mould forms the face, and the tool or profile the back or exterior. In hollow ware, such as cups, bowls, soup-tureens, chambers, &c., the mould forms the exterior, the profile shaping the interior. As a mould is necessary to form every shape or size made on the machine, so is a profile necessary to suit each shape. The making of these tools or profiles is, therefore, of the greatest importance, and they require the utmost nicety in filing and arrangement.

Let us first take as an example a profile for making plates. A sample profile is first made out of a bat of plaster about $\frac{1}{2}$ in. thick; this bat is cut the exact shape required for the back of the plate, a groove of the shape desired to make the foot also being cut out. This groove should be widened out in a V-shape on the bevelled side, so that more clay is admitted than can easily pass through it, and consequently the foot is made more solid than it otherwise would be. If the plate has to be made according to sample, its details of shape and form must be carried out in the plaster pattern. It is then tried over the plate mould, and should extend from the centre of the mould to the spare edge, and if accurately made it should leave the exact space, between it and the mould, required by the clay to form the plate. If not exactly as it should be, the plaster is carefully shaved away till the requisite shape and thickness are attained. The plaster profile is then handed to the blacksmith, who cuts from $\frac{1}{2}$ in iron plate or forges a tool and files it as near as may be identical with the pattern.

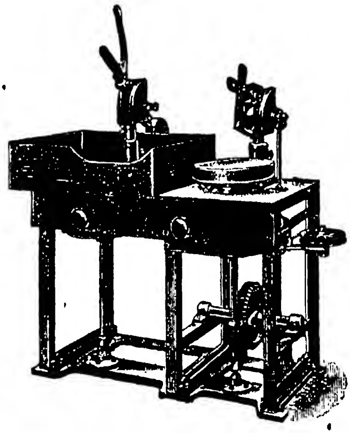
The tool would be about $\frac{1}{2}$ in. thick, bevelled away on the right side, so that the edge in actual contact with the clay is about as sharp as a blunt knife. The tool is made about a couple of inches in width, with a piece about $1\frac{1}{2}$ in. wide and 3 in. long projecting from it, forming the attachment to the holder. This is also pierced in nearly its whole length by a hole about $\frac{1}{2}$ in. wide, so that when fixed to the holder with a screw and nut, it can be placed at any angle required. It is then handed back to the foreman of the jiggerers, who is responsible for the setting of the tools on the various machines; he tries it by fixing it on a machine and making a plate off the mould. It is almost certain to require some slight alterations, so that he must be a

first-rate filer to accurately finish the tools, besides having a practical knowledge of potting and machine-made ware to arrange the thicknesses as they should be.

The position of the "ball" of the plate and the angle at which the edge is set on affect to a very great extent the percentage of loss from crooked ware in firing. Having obtained a clay plate to his liking, he cuts it carefully in half with a sharp penknife, and examines the section to see that he has the "strength" or thicknesses of clay in the right place, and if to match a sample it is again compared. And let it here be noted that when making to sample it should be copied with fidelity to the minutest detail; the smallest deviation in some apparently unimportant point (for instance the height or breadth of the foot of a plate or the distance from the centre at which it is made) may result in the whole order when finished being left on the manufacturer's hands. When the tool is finally set in the holder as it is to work, it should be firmly screwed up to avoid all chance of movement. Then another plate should be made and cut in half to make sure that in the act of screwing up tightly, the angle of the tool has not been slightly altered.

Once properly arranged, the workman should not be allowed to alter the setting of the tool on the holder, and the foreman should be solely responsible for the setting, and if any alteration is required, he should be called to attend to it. If the workman wishes to make plates of a different shape or size, he merely has to remove the *tool-holder* from the socket of the arm and insert another holder with another tool attached to it. This in no way affects the setting of the tool, as the holders fit in always in the same identical position. It is therefore best to have sufficient tool-holders for the shapes in current use, and the tools once set correctly

on the holders can be taken in and out of the arms as required, and time is not lost in continually resetting tools, for some shapes take up considerable time and trouble before a nice adjustment is procured. To avoid mistakes in thickness of plates it is as well to have a metal gauge of the thickness it is intended to make each shape and size of plate, and marked with its name and size.



COMBINED JOLLEY AND BATTING MACHINE.

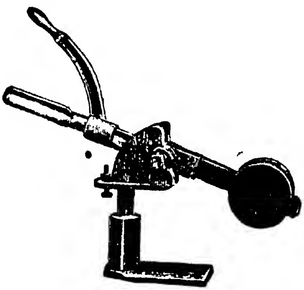
When it is desired to set the tool the metal gauge is laid on the mould, and the tool is brought down till it touches it and then fixed. By this means, however long an interval has elapsed since the last lot of plates of that particular shape or size were made, they can be reproduced of exactly the same thickness as before. If several machines are making the same shape and

sized plate the gauge is used to set each tool, and there is thus no difficulty in obtaining the work of uniform thickness. A hole can be made in one end of the gauges, to hang them up, so that they are always at hand when wanted.

The machines for small flat and saucers are similar in construction to those for large flat but slightly smaller; this is really of little importance, and identically the same machines will do, but the machines for smaller ware can with advantage run slightly faster, and so should have

HEADS.

smaller driving-wheels on their spindles. In the most modern pattern of plate-making machinery the bench or bed of the jolley and batting machine are cast in one piece, so the machine has merely to be put in position and the rope run through, when it is at once ready to start work.



Hollow-Ware Jolleys.—Small hollow ware can be made on the machines used for flat ware; the heads, however, must be deeper, and shaped like an ordinary flower-pot, so that the moulds fit well down into them. They require the same nice adjustment as heads for flat, and must run equally true.

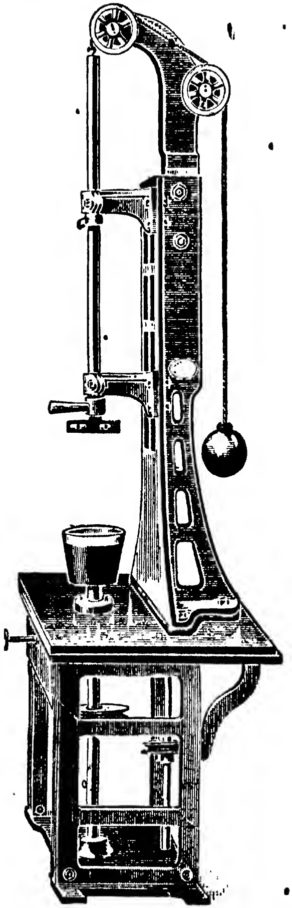
In hollow ware, as already stated the tool forms the

inside of the piece, and the tools have therefore to be fitted and arranged to the inside of the moulds, the same process of making a plaster model has to be gone through, and the iron profile is made from it, fitted with equal accuracy and tested for shape, size, and thickness in the manner already mentioned. There is indeed more care required with hollow-ware tools in order that they should "deliver" properly, that is, come out of the piece without touching it as they are lifted up. The tool being fixed to an arm working on a pivot describes a segment of circle, of which the pivot is the centre, in coming up, and therefore if the piece is much undercut, that is, with much belly and small mouth, the tool when raised would touch the mouth of the piece. To obviate this difficulty, the "spring-arm" has been brought into use. The arm to which the tool is attached has a hinge in the middle which is kept closed by a strong flat steel spring screwed on underneath. The hinge opens slightly, and is prevented from opening farther by a stop. When the arm is pulled down to the horizontal position and will go no farther, pressure still being applied to the arm, the hinge opens as far as it will go, and thus allows the tool when in the mould to be introduced a little under the edge or mouth of the mould, and thus to form the belly of the piece. The tool has, of course, been previously set in this position with the spring arm bent down to its fullest extent. The moment the operator takes the pressure off the handle the spring comes into action, closing the hinge, straightening the arm, and drawing back the tool from under the edge of the mould, and the tool delivers without touching the piece. The spring arm therefore is the tool-holder, so several arms will be required to avoid the constant resetting of tools.

It is extraordinary what can be done with tools, and

pieces that at first sight appear impossible to manufacture on the machine can often, with a little thought and judgment in the arrangement and shape of tools, and the angle at which they are set on the holder, be made satisfactorily. Sometimes they have to be made in two or three pieces, at other times upside down, the bottom made on another machine and afterwards "stuck up"; but wherever quantity is the first object it will generally be found that machine-making will be the most economical method of manufacture in spite of the increased number of processes and the time occupied in the preparation of moulds and tools. In fact, one of the difficult points often to decide is which is the best of several methods for the production of some special piece For larger pieces, such as salads, soup-tureens, &c., a larger and rather higher machine is required, but made on exactly the same principle. The batting machine is larger, and should run rather slower, the plaster block or head being increased in accordance with the size and thickness of the bats that have to be made off it.

The *Upright Jolley* or *Monkey* is another machine, most useful for the production of soup-tureens, chambers, jugs, jars, and any pieces with big bodies and small mouths. The motion to the spindle is conveyed in the same manner as to the machines already described, but fixed behind the spindle on the bench, or bolted to the bed of the machine, is an iron standard about 7 ft. high; two short arms project from this standard, one about 3 ft above the bench and the other about 2 ft. 6 in. above the other arm. At the end of each arm is a collaring, and through the two collarings an iron shaft about $1\frac{1}{2}$ in. in diameter slides up and down directly over the spindle. To the top of this shaft is fastened a cord which passes over two wheels at the top of the standard,

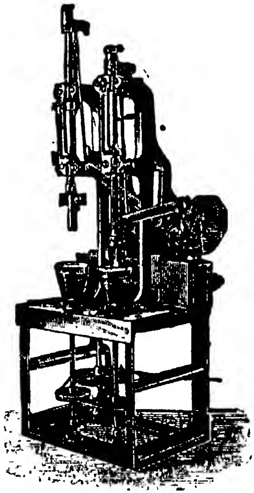


UPRIGHT JOLLEY.

and is attached to a heavy weight behind, thus counterbalancing the shaft and tool, and enabling the workman to raise it or depress it with ease. At the lower end of the shaft is a socket into which the tool-holder fits, held tightly by a set pin. On the left-hand side of the shaft (it is supposed in all these descriptions that the right and left are those of the operator standing in front of the machine) is a handle by which it can be turned round, and on the shaft is fixed a projecting piece of iron about a couple of inches long, fixed by a collar round the shaft above the lower arm.

When the handle is pulled round, the projecting piece of iron on the shaft fits into a catch on the right-hand side of the standard, and the shaft is thus held rigidly in position. The collar can be moved up and down the shaft and fixed

in any position by a set pin, and is fixed on the shaft at the point at which it is desired to stop its descent, which occurs when it comes in contact with the lower arm. The tool is bolted on the tool-holder and set in such a manner that when the shaft is turned round and held by the catch, it is at its work making the article in the mould revolving on the spindle, and when it is turned back the tool comes away from its work and, the shaft being raised, it is lifted out of the piece without coming in contact with it. By this means pieces that are much undercut, or that are deep with narrow mouths, can be made, which would be impossible off the ordinary machines on account of the tools not "delivering". A smaller sized machine, constructed on similar principles, may be used for undercut cups or small ware, the spindle running faster in proportion. Machines are now made on this principle, both double and automatic as in the annexed cut.

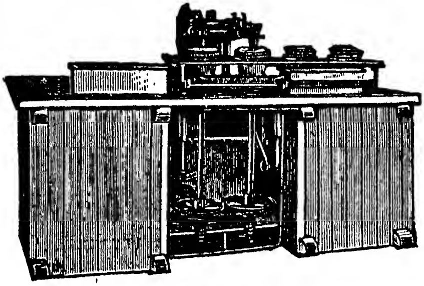


Double Automatic Upright Jolley.

Automatic Cup-making Machine invented by Mr. Wm. Boulton. This is the next machine to be mentioned, and a very useful one it is, as it will produce with great rapidity all those small articles which have afterwards to be passed on to the turner, such as cups, cans, patch-boxes and covers, egg-cups, powder-boxes and

covers *et hoc genus omne*. It is a rather complicated piece of mechanism, as there are four distinct movements which are accurately arranged to perform their operations at the appointed time.

The first movement is the rotary, causing the spindles to revolve, the newest models being made with two heads, and thus forming two pieces at once. The heads are similar in shape to those on the ordinary hollow ware jolleys, that is to say, like garden flower-pots.

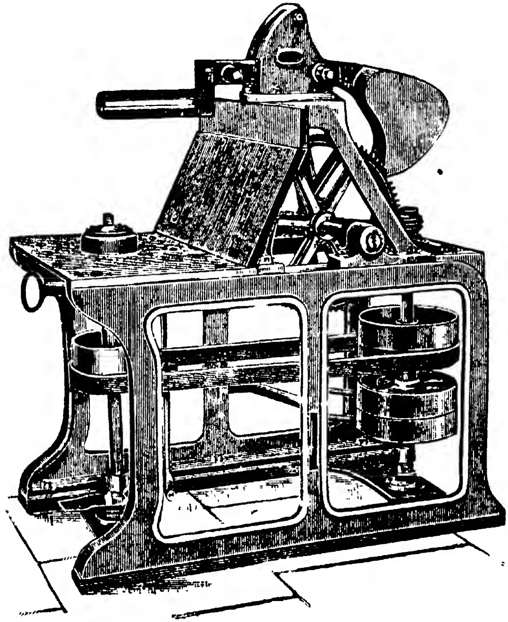


AUTOMATIC CUP-MAKING MACHINE.

The second movement causes a platform carrying the moulds to move from one side to the other, bringing in turn each pair of moulds exactly over the heads running on the spindles; and while the one pair of moulds is revolving on the heads the other pair is having the moulds with the finished pieces removed and fresh moulds substituted. The moulds are held in false iron collars on the platform, and when the platform gets to its lowest point the moulds over the heads of these collars fit into the heads and the motion is thus conveyed to the moulds. Above the spindles are the tool-holders, which, as soon as the platform has placed the moulds in the

heads, begin to descend, carrying the tools into the moulds. This is the third movement.

The tools require the same careful arrangement as for other machines. When they have been in the mould a sufficient time to form the piece, two light arms with



AUTOMATIC JOLLEY FOR MAKING WASH BASINS, CHAMBERS, ETC.

thick needles, or, better still, with pieces of thin wire stretched between the ends of steel forks, descend and just touch the inside edge of the mould, cutting away any superfluous clay as the mould revolves. This is the fourth movement and the operation is finished.

It is as well to have let into the piece of bench that runs in front of the machine a narrow tin trough for water: about $1\frac{1}{2}$ in broad, 2 in. deep, and a couple of feet long is quite sufficient, just to allow the workman to wet his fingers. When the machine is running satisfactorily it is as well to mark on the different rods, levers, &c., the exact position of the various connections, so that if at any time a screw slips and one part of the motion gets out of gear, it can be placed at once in its proper position; otherwise it will probably take a considerable amount of time and a lot of experimenting before the machine can be made to run with its former accuracy.

The Automatic Chamber and Basin Machine.—This is another very useful machine, especially in the manufacture of very large pieces, such as plug basins. It is made much on the same principle as the plate machines already described, but on a much larger scale. That is to say, it has the motion conveyed to it by the rope, but in this case it is connected by a belting to the driving-wheel; and after the spindle has been running some time the arm, which is counterbalanced by a heavy weight, descends automatically by a system of cogged wheels. The tool is thus held perfectly rigidly to its work and far more steadily than would be the case if held down by the human hand, as very great strength is required in making extra large pieces on machines.

The limit of size in the pieces that can be made on it is practically double the measurement from the spindle to the upright supporting the arm, allowing for the thickness of the mould. The machine has a treadle affixed, which is connected with the automatic arm, so that if the workman has not finished the preparation of the clay in the mould for the reception of the tool, he can delay its descent and then set it in motion when

CHAPTER IX.

AUXILIARY PLANT AND APPLIANCES REQUIRED BY MACHINE JIGGERERS.

Drying Stoves are the most necessary things to be referred to under this heading, and they play a very important part in the production of good machine-made ware. It is not only that the production of ware on the machines is so large, but that the number of moulds required for rapid production is so great that very considerable drying space is required. Each plate-maker will require from 50 to 80 dozens of plate moulds if he is to work his machine up to its full producing power, and it is clearly false economy to reduce the number of moulds that can be employed, but the more heat there is in the stoves the less moulds will he require, as the clay ware will dry quicker and come off the mould sooner, and the mould can therefore be used the oftener.

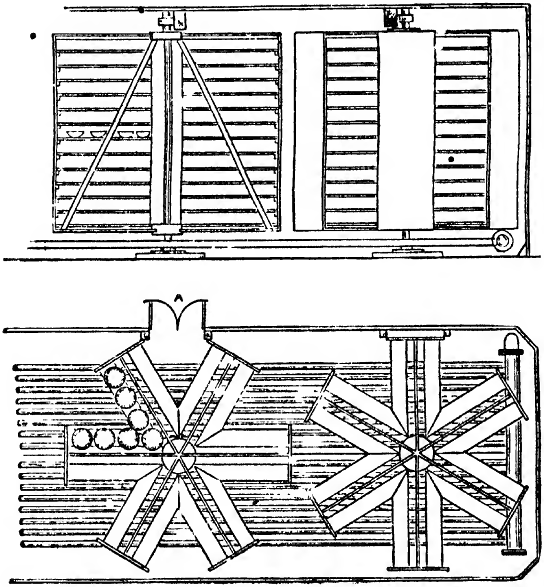
An important point in the arrangement of stoves is that they should be as near the machines as possible and in a convenient position for the removal and replacement of the moulds. When possible the doors into the stoves should be exactly behind the man working at the machine. Removing and replacing moulds all day long is considerable work, and the less distance the boys have to travel, the less time is taken up, and in consequence the production is larger. If the stoves are some way off the jiggerer may have to employ an extra boy, and would therefore require a higher price for his work than if they were more suitably placed. The stove room required by each plate-maker under the modern system of arrangement is about 12 ft. square and about 10 or

12 ft. high. In the centre of the floor is fixed a socket, in which revolves an iron shaft about 9 or 10 ft. high, though it can of course be any length to suit the head room, supported in a bearing at the top—about 2 ft. from the bottom horizontal arms of angle iron are attached to it fitting firmly into grooves. The number of arms will vary in accordance with the size of the stove, and the space between each of these arms will form one division or compartment of it; six or seven is the number generally in use. The ends of these arms are connected with the top of the shaft by iron ties firmly bolted on, thus forming a rigid iron frame.

At the top of the shaft are also, fixed in grooves, iron arms corresponding to those below, but not connected at the ends. To these arms boards are bolted from top to bottom, thus forming the different compartments—which are sections of a circle. Each compartment is filled with shelves placed at a suitable distance apart for the moulds they have to contain. The doors into the stove should be made just the width of one of these compartments, so that by pushing the revolving frame round each section is successively brought in front of the door for the removing and replacing of the moulds. Where space is of importance the door should be divided in two parts and thus occupy very little room in opening.

If constructed for plate moulds, the shelves are close together, and fifteen or sixteen shelves can be arranged on each side of the compartment, and as each shelf will hold from nine to ten moulds, according to their size, a stove having seven compartments would hold quite a thousand moulds, or over eighty dozen, which, as already stated, is more than sufficient if reasonable heat is kept up in the stoves. The sockets of the stove should be oiled from time to time, so that the frame

can be easily moved round, and it is as well to distribute the moulds in the different compartments fairly equally —as, if one side is full and the opposite side is empty, the strain on account of the heavy weight of the moulds is so great that the frame may give a little and not



REVOLVING STOVES.

revolve with the facility it should. The revolving stove is then about 2 ft. above the floor level to admit of the piping passing under it; therefore, inside the door of the stove will be required a piece of flooring about the width of one of the sections. A small step

ladder should be provided for each stove, to enable the boys to remove the moulds from the upper shelves.

Apart from the greater facility in removing and replacing the moulds offered by the new system there is another great advantage, and that is, the apprentices do not have to be continually running in and out of the heated atmosphere, as was the case in the old-fashioned drying-rooms, which was undoubtedly a harmful proceeding. The stoves also hold many more moulds than they would under the old arrangement.

The present system of warming the stoves is by beds of steam pipes, heated by the exhaust steam from the engine. This certainly is a great economy, the steam, instead of blowing off uselessly in the air, is conveyed by a main pipe through the different shops and led by the various supply pipes into the different stoves. Each supply pipe is fitted with a valve so that the steam can be shut off or turned on as wanted. In very damp weather the steam supply may be insufficient. The foreman potter should therefore have control of these valves and put on the steam to the stoves as he considers they require it, and the workmen should not be allowed to turn on the steam as they like, or it may happen that the first stoves on the main pipe are using a great amount of steam, often quite unnecessarily, while the last stoves are getting little.

The beds of pipes may consist of any number of tubes, but for revolving stoves of the size described, probably two beds of twelve tubes each would be a sufficient number. The tubes should have an incline from one end to the other of about 1 in 20 or 30 to facilitate the exit of the condensed water. One bed should be sloped one way and the other the other, and the connection with the main steam pipe should be in each case at the highest end, as by this means, if the

tubes pass through several stoves under the revolving frames, the heat is more equally distributed. The tubes fit into iron castings at each end, arranged in such a way that the condensed water runs off at the lower end without permitting the steam to blow off.

Should there be insufficient steam to keep up the heat required, a small pipe of live steam direct from the boiler can be run into the main steam pipe, care being taken that it does not put back pressure on the engine. This is suggested for exceptional occasions, as it is evident that extra steam will have to be made in the boiler and that the expense of production is increased. Heat is an absolute necessity, for the economical working with machinery, and want of it is often the cause of heavy loss in clay ware. The workmen requiring moulds, to continue working, get off the ware too wet, bending it and putting it out of shape. Plates taken off too soon and "bunged up", one on the other, owing to their weight leave footmarks on the surfaces of the lower plates, and those marks give an ugly appearance to the plate which is accentuated in the firing. The moulds, too, not being properly dried, become soft and perish, and apart from the actual extra number of moulds required the loss becomes excessive, and the ware produced from moulds that have lost their absorbent power is never satisfactory.

The stoves require some ventilation at the top to enable the moisture driven off by the heat to escape, and it thus considerably accelerates the drying. The tubes require attention from time to time, as, should the exits become in any way stopped up, the pipes remain full of water and the steam being unable to pass, their heating power ceases. The stoves will also want cleaning out now and then, as broken clay ware may fall down and the dust from the drying ware, moulds, &c., forms

in time a thick coating of dust and dirt over the tubes, which tends to considerably decrease their heating power. For large hollow ware the revolving stove is unsuitable as there is no saving in space, and ordinary shelving round the stove room must be used instead, though the method of heating may be the same. Neither is it so important from the health point of view, as these pieces take more time to make and there is not the same running in and out of the stoves as in the case of the smaller pieces which are manufactured with such celerity. Whenever a stove is not in use the doors should be kept closed to retain the heat for drying purposes and not to overheat the shops.

Whirler.—Each jiggerer will require a whirler with a plaster head similar to that described for pressers, but smaller and lighter for fettling and cleaning the ware and polishing the edges of the plates.

Clay Guards.—Each machine should have a square wooden frame round it on the bench about 8 in. high at the back and sides and lower in the front, so as not to interfere with the operations of the workman; a slit must be cut in the back to enable the arm attached to the counter-weight to descend to its proper position. This prevents the extra clay cut off, as the piece is revolving, from being thrown about the bench and floor. The sides should be made with a ledge on them sufficiently broad to put the mould on before and after use. There is no occasion for the frame to be fixed to the bench, in fact it is better loose, as it can be lifted off and on to remove the clay and clean the bench. It is also as well to have the bench round the head inside the guard-box covered with zinc, which is easier to keep clean than the wooden bench.

Ware Boards.—Work boards are required in large numbers to put the work on, and considerable care is

required in their selection. They should be planed perfectly level and must be as free as possible from knots, as in sliding the boards in and out of the stillage the knots are likely to catch on the wooden cross-pieces and the sudden jerk may throw the work off the board and break it. They should be about 6 ft long, 1 ft wide and about $\frac{3}{4}$ in thick. In the thickness of the board *at each end a groove should be cut sufficiently deep to* admit of the insertion of a piece of hoop iron 1 in. wide, kept in its position by a nail at each side passing through both the board and iron This, apart from preventing the board from splitting, prevents it from warping and going crooked

Crookedness in boards is a very serious defect, as, if they are not quite flat, the pieces on them being still damp will take the curve of the board, and should they be soup tureens, &c , with thin and delicate feet, the probability is that they would go crooked. The iron in the ends undoubtedly increases their durability. The boards should be, in the first instance, well seasoned, as being constantly covered with damp ware and subjected to considerable heat in the stoves and drying rooms they have every excuse for warping.

Boards are used in many of the different departments on the works, and it is very necessary that they should be kept solely for the work in the department to which they belong and not be interchanged, as after being used in one department they may cause defects if used in another. For instance, a board which has been used to put ware on after dipping has always a few drops of glaze on it, and if clay ware were then put on it the glaze would probably stick to it, and on going into the biscuit oven the little drop of glaze would fuse, making a hole in the clay and rendering it defective. In like manner a board used in the printing or painting

shops might have a little colour on it, and if used in the dipping shop a piece damp with glaze may pick it up, and thus the edges or foot of the piece would come out of the glost oven discoloured.

If for any reason one department is short of boards, the people to continue their work will procure them from wherever they can, and to prevent this it is better to have the ends of all boards painted a different colour according to the departments to which they belong. If clay boards are not painted then all others should be; for instance, the boards in the dipping house may be painted red, those in the printing shops blue, those in the enamel shops white, &c. This avoids all chance of the boards being accidentally crossed, and any board of one department in a shop to which it does not belong is at once detected and sent back to the department to which it belongs. It is well to impress on all new hands that a board has *two ends*: a lot of ware is broken by boys forgetting this, and seeing the end of the board clear in front of them they swing round, knocking over ware behind them. Besides their stoves, jiggerers require as much shelving or pegs to put boards on as can be found room for to place their ware on after it has come off the moulds both before and after fettling. Insufficient accommodation is a great cause of breakage, plates are bunged too high, ware is put on the floor, where it never dries so well as when put above the floor level, &c.

The Tools required by the jiggerer are of the simplest kind, and consist of a piece of wire stretched between the points of a metal fork, or a piece of steel like a knitting needle, both used to cut off superfluous clay as the piece revolves, and a sponge or two. And for fettling he will require a few pieces of narrow iron or steel with the ends turned up similarly to the turner's

tools, but grooved and sharpened for cleaning round the edges of the ware, and a few pieces of cloth or flannel if the pieces require an extra finish.

There is a great difference in the quality of sponges, but the quality used by jiggerers need not be so carefully selected as those for pressers, though the platemakers will require a fair quality of sponge for fettling plates. A jar of clean water also forms part of his equipment as of every other potter.

Each jiggerer should also have a wooden frame with nails driven into it to hang the tool-holder and tools on, which he is using every day, arranged in such a way that they just hang clear without touching, otherwise if left lying about or put one on the other the edges are likely to get knocked and so dented and spoilt.

CHAPTER X.

THE MANUFACTURE OF CLAY WARE BY MACHINERY.

HAVING roughly described the object of the different machines, we will now proceed to the production of ware on them, and keeping to the same order in which the machines have been mentioned, we will commence with *Plate Making*.

A plate-maker to work his machine to its full capacity will require three boys or attendants. The first to make the bat on the batting machine and to place the clay bat on the mould, the second to receive the mould with the clay plate on it, carry it to the stove, remove the dry plate off another mould and hand the mould to the boy making the bat, and the third boy to fettle and finish the plate. By this arrangement the plate-maker is continuously working and no time is lost. Some plate-makers prefer to finish their own work, and in this case two boys will be sufficient.

The boy first takes a lump of clay, and making it into a ball in his hands places it in the centre of the plaster head of the batting machine and starts it, the tool descends and spreads the bat out to the thickness required. He then takes the bat off the machine and throws it with considerable force on to the mould, which he should first see is clean, and, if necessary, blow the dust off it or wipe it. The face of the bat made by the tool is that which should come in contact with the mould. Care should be taken that the centre of the bat made by the tool should also be as near as may be the centre of the plate, but probably this is rather more insisted on in theory than actual practice demands. The object of

throwing the clay on to the mould is to drive out all air and to fix the clay firmly on the mould, and if there be any incised pattern on the mould to impress the clay thoroughly into all the cavities.

The plate-maker then takes the mould and places it on the jigger head, and with his leg presses the lever which brings the rope into contact and the head begins to revolve. He firmly presses the clay down on to the mould from the centre to the edge, with the ball and palm of his hand previously moistened in water, and to obtain extra force presses one hand on the other. This is also to drive any air out that may have remained under the bat and to press the clay solidly on to the mould. He then cuts off any extra clay from the edge and pulls down the arm to which the tool is attached. This he should do steadily and without any jerk, so as to remove the superfluous clay gradually; were he to pull down the tool to its fullest extent at once it would stick in the clay and the tool would jump or "chitter", causing ridges in the plate which might become visible after firing, as it would really be the equivalent of unequal pressure

The object of bevelling away the tool is the admission of rather more clay than can pass under it, and this increases the pressure on the clay and makes the plate more solid; as the extra clay is removed by the tool it runs up on to it, and the plate-maker should clean it off with his hand to prevent it falling back on the half-finished piece. The tool is then pulled down with the left hand to its utmost limit, the right hand being free to do any work necessary; the screw underneath the arm prevents it going any further than it should, unless such extraordinary force were used that it bent the arm. As the plate rotates it may be necessary to moisten the clay slightly to finish the work nicely, but it must be borne

in mind that, as the tool can only descend to a certain point, the clay passing under it will form the thickness of the plate, and this thickness will be the same whether the clay is very wet or very dry, so it is important that the clay should be worked of the same consistency, otherwise if worked very wet there will be a superabundance of water and the contraction in drying will be much greater.

When the tool has done its work the plate-maker lets go the arm and the tool at once rises to its former position by the weight of the counterbalance. He then takes his scrapping tool and cuts off the excess clay from the edge of the mould up to the point where the spare edge commences, taking care that he does not cut or damage the mould. He next removes the mould from the head, places it on the ledge of the clay guard, and the boy runs off with it to the stove, having previously impressed on the plate the maker's number and, if necessary, the mark of the firm and the size of the piece, while the plate-maker proceeds in the same manner with the next mould; the whole operation taking about as long as it would take to read ten lines of this description.

When the plates are sufficiently dry to be taken off the moulds, and it is a great mistake to get them off when wet, they are placed on the whirler, the edges trimmed with a tool and the surface carefully sponged and leathered to remove any imperfection, or when drier they may be rubbed with fine glass paper with the same object. If the plates are going straight to the oven without any further process the greater the care required in finishing them; they are then placed in bungs twelve high to facilitate counting. Each bung is placed on a "setter", which is an extra thick plate made for the purpose and fired in biscuit; sufficient sand, flint, or ground pitcher is placed in it to form a bed to support

the lowest plate of the bung. Instead of setters seconds biscuit plates may be used, but as they are often slightly crooked they are inferior to the specially made "setters".

Should the plates be required extra good, when white dry they are flannelled or towed on a whirler, and where much work of this description is done special towing machines are employed having hollow plaster heads covered with flannel. These machines are simply small whirlers run by the rope, and covered in with glass cases, having an aperture in front by which the piece can be inserted, with room for the hands to use the flannel or tow. They should also be fitted with an exhaust fan to draw away the dust. Without these precautions the dust rubbed off and floating in the air would be breathed by the operator, which would be most detrimental. Small plates, saucers, and other flat ware would all be made in a similar fashion, as also the tops of compotes. Round dishes would also be made in the same way, but will require more careful treatment on account of their size.

Small Hollow Ware can be made off the same machines; bowls, mugs, cups, sugars, butters and their various covers and stands, are all made with facility. In making bowls, mugs, or cups, the batting machine is dispensed with, and the boy makes a ball of clay in his hands and throws it into the mould; in the case of bowls he uses sufficient force to fill solidly the cavity which is afterwards to form the foot. The tool is at once introduced into the mould, the superfluous clay runs up the tool and is cleaned off, and the extra clay on the edge of the mould is cut off with a scrapping tool. The mould is then returned to the stove and the piece when dry is handed on to the turner or fettler to be finished. The bowl-maker will require two attendants if he is to work at full speed.

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needle cuts a small hole in the centre of the clay bat; this is to enable any air to escape He then again runs the clay down, but this time right to the centre, driving out any air that may be under the bat, and at the same time closing the hole solidly by pressure on the clay. The clay bat being thus pressed into the form of the mould the tool is introduced and the superfluous clay removed, the potter at the same time smoothing the clay surface with a wet sponge to facilitate the working of the tool The extra clay at the edges is then cut off with the scrapper, and the work being finished is carried to the drying stove.

In the case of soup-tureens and such-like pieces, which are made in several parts, it is as well, if the feet and covers, &c., are made off the same machine, to make a few of the different parts in turn, and not to make all the bodies first and then all the feet and covers, as the various parts will not then be in a similar condition of moisture. If they are made on separate machines the jiggerers must arrange their work to suit each other, otherwise there will be a heavy loss in the sticking up.

Covers dry very rapidly, especially at the top, where the knobs have afterwards to be stuck on. It is well, therefore, when making many of them to stick a lump of clay on the top of each when finished, and this, while not interfering with the general drying of the piece, keeps the top in proper condition for sticking on the knob. Salads of certain shapes, which have a pattern inside and are made on outside moulds, that is the tool forming the exterior, require great care in getting off the moulds at the right time, as if they are very straight-sided, and not much bevelled off, they contract, and the mould being rigid they will split. They should therefore be taken off the moulds before they have contracted very much, that is to say, in rather a more

moist state than would be desirable with the general run of ware. They can generally be easily removed by knocking the mould slightly with the hand to loosen the piece, and then blowing under the edge to separate it from the mould.

Hollow ware made on the Upright Jolley is almost always made by placing a ball of clay in the mould, and in the case of chambers, &c , by running the clay with the hand or with a wet sponge from the bottom to the top of the mould, reversing the process as described for the ordinary machine; by this method a rather stronger article is obtained, but otherwise there is no apparent difference in the two processes. Chambers made in this way dry rather more slowly than when made with a bat, and must therefore remain longer in the stove before they can be extracted from the mould. The advantage of making chambers by machinery over the old system of throwing them is that they are made of the exact shape required, and when handed on to the turner have merely to be trimmed and polished and not turned as formerly. In fact, if the turners are very busy with other work the machine-made chambers need only be fettled and sponged and they are quite good enough to go straight on to the oven as they are, though, as has already been noted, a better article is obtained if polished over by the turner.

Other pieces such as jam-pots, chemists' jars, jugs, &c., are made by merely putting a lump of clay into the mould, the shaft being pulled down and tool allowed to do the whole work, the workman simply cutting off the extra clay from the edges.

Cups may be made on the small plate machines, or on the *Automatic Cup-making Machine*. The latter, if furnished with two heads and four collars to carry the moulds, will, with a sufficiency of moulds, produce

an enormous number of cups, small bowls, egg-cups, patch boxes and covers, sugar and butter tops, teapot covers, &c., in fact any small article that is not undercut, and it really takes the place of the thrower in all small work that afterwards requires turning or polishing. It will require two revolving stoves with as many shelves as the size of moulds permit, and if the machine is to be kept in full swing the man attending to it will require three or four boys to fill and carry away the moulds from each side of the machine as he takes them out of the heads.

Working the machine with both heads making the same article is simple enough, but when one head is making one article and the other another the strictest attention is necessary, as if a wrong mould were put in the head the tool on descending, not being arranged for that mould, would probably catch on the edge or inside the mould, and the least damage done would be the mould split or cut to pieces, and very probably, the machine would be strained and thrown out of gear. It is therefore very essential to have active and attentive people tending this machine.

The boys standing on each side of the machine throw lumps of clay in the mould, and place them in the rings on the platform, and the journeyman standing in the middle sees that the moulds run true, and that the pieces are properly made, and sprinkles a little water from the trough in front of the machine on the clay as the tools do their work, also from time to time moistening the scrapping wires with his fingers, which makes them cut cleaner. Should there not be sufficient clay in the mould he takes it out, and one of the boys puts a little more clay in and again places it in the platform. The journeyman takes out all the moulds as the work is finished, and the boys run off with them

to the stoves. It will thus be seen that no skill whatever is necessary to work this machine, and given the proper moulds, and the tools set as they should be, attention and activity are all that is required on the part of its attendants.

Basins of all sizes, as also chambers, can be made off the *Automatic Basin and Chamber Machine*, but it, perhaps, shows to the greatest advantage in the production of large basins; formerly the majority of these were made on outside moulds, but making them from the inside is undoubtedly easier, and the losses with them are less.

The bat is made on the batting machine, and carefully placed in the mould, great care being necessary with these very large bats not to break them. The machine is then started by pulling out the lever, and the bat is run into the mould carefully with a sponge, the same process as has been described in making chambers being gone through to make sure that there is no air under the bat. The arm carrying the tool is so arranged that it just allows the basin-maker time in ordinary sized pieces to do the necessary work and then begins to descend. All he has to do is to sponge the clay surface as it rotates to assist the tool in working, and clear the clay off that sticks to the tool and scrap the edge of the piece. The tool is arranged to remain a sufficient time in the piece to do its work, and then rises automatically back to its former position. The machine is then stopped and the mould taken off to the stove.

If the basin-maker is working without an attendant, he should always get someone to assist him in lifting very large moulds in and out of the head, as otherwise they may get broken, or, at any rate, chipped on the edges, when they become useless, or chipped on the edge of the natch that fits in the head, when they cease

to run true, and moulds of large size are very costly. In making the largest sizes it will probably be found that the arm comes down a little too soon, and does not give the workman sufficient time to arrange the bat in the mould; he should therefore throw the arm out of gear by putting his foot on the treadle and only allow the head to revolve, and when quite ready he can throw the arm into gear again and the tool descends to do its work. The great advantage in this machine is that the tool is held absolutely rigidly to its work. There is no possibility of the tool jumping or chittering, which would be almost inevitable in pieces of large size if the arm were held down by hand. In all big work it is an advantage to a man to be tall, as he dominates his work better, and it is less exertion to him than it would be to a smaller man.

Chambers may equally well be made off this machine, as also round dishes. It has now been attempted to roughly describe the manufacture by machinery of a few of the articles in most general consumption, but to describe all the different applications and methods necessary for the production of special pieces would be quite impossible A slight difference in shape may necessitate a complete alteration in the procedure of manufacture, and a system of production in one pottery may be quite unsuited in another. But one thing is certain, and that is that there is hardly a circular piece, if required in large quantities, that cannot be made more economically by machinery than by hand, and the greatest interest often lies in deciding which of various methods on the machines is the best, and what will be the most suitable forms for moulds and tools.

At the end of this chapter should be mentioned the manufacture of pieces by *dies*. The press containing the dies consists of a vertical shaft which can be depressed

by a lever, which, when released, returns to its original position by the action of a counterpoise. At the end of the shaft or plunger is fixed one half of the die or mould, the other half being fixed in a frame exactly under the plunger. A piece of clay is placed on the lower half of the metal mould, and the lever being depressed forces the other half of the mould or die attached to the shaft down on to the clay, thus compressing it between the two halves and forming the piece. In many pieces it is necessary to have minute holes bored in the dies to allow of the escape of air, and there is usually an arrangement of a rod worked by a treadle from below, which can be pushed up through the die to push out the piece after it is finished. Dies are not very generally used in the actual manufacture of earthenware, though ash trays, pickles, &c., are often made with them, and they may be applied with success to the manufacture of many small articles required for electrical or scientific work; they are, however, used very largely in the production of thimbles and stilts and spurs, to which reference will be made in due course.

It is difficult to appreciate the exact effect that the introduction of machinery has had and will have in the future in the development of the pottery trade. As has already been noted, the thrower has been ousted by the machine, which practically dominates the production of all round articles, and has already made considerable inroads on the territory of the producer of oval shapes. Flesh and blood cannot compete at any rate in cheapness and quantity with iron and steam. That prices have been very largely reduced is evident, and to that extent the public have clearly benefited, as it enables many, who formerly were unable to afford the expense, to procure many articles which render their daily life more agreeable and comfortable.

The worker turns out a considerably larger quantity than formerly, but probably at much the same wage as he used to turn out the smaller quantity; though it may perhaps be held that though he has not absolutely gained by an increase of wages, he has some gain in the ease with which he can now produce his work, as the actual labour is much less, though greater activity and celerity are required. The manufacturer probably comes off worst in the final account, as he has had all the expense of the erection of machinery, but owing to the consequent fall in price, he has not reaped the benefit that was to have been expected. The machinist and engineer certainly have largely benefited, so it really looks as if the chief benefits have been conferred on those outside the trade.

There is one other point worthy of note, and that is as the tendency of machinery is to the manufacture of round pieces, therefore all shapes except the circular are avoided as much as possible, and the scope for the modeller is considerably reduced. But perhaps the chief disadvantage in machinery is that only pieces required in very large quantities can be made with its aid, as the initial cost of tools and moulds is so heavy.

CHAPTER XI.

DECORATION OF WARE IN THE CLAY STATE.

THERE are many simple ways of decorating ware in the clay state, and it is proposed to mention briefly some of them.

By Application.—That is, after the piece has been made, and while still in the moist state, figures, flowers, masks, geometrical designs, etc., may be made in clay out of moulds, either of plaster, pitcher or metal, and applied to the surface being carefully stuck on with slip. The superfluous slip is sponged off and the operation is complete.

Drapery, &c., may be reproduced by dipping lace net, &c., into liquid slip and then laying it on a plaster bat to slightly dry, or better still, first make a thin coating of slip on a plaster bat, then stretch the textile fabric on it and cover it with another thin coating of slip. The plaster bat absorbs the water, leaving a thin layer of clay on the fibres of the material. Were it not for the action of the plaster the interstices of the fabric would be filled up as well. The material, while still moist, is applied to the figure or piece, and during the firing the material is destroyed while its clay facsimile is solidified. Ferns and leaves may be somewhat similarly treated.

By Impression.—This is either done by the impression of small dies on the ware or by the use of rollets with different patterns cut on them, which are pressed on and run round the piece forming a continuous pattern. The ware must be sufficiently soft to easily receive the impression, and yet of sufficient stability to avoid

deformation. This latter style of decoration is largely used in connection with the lathe, as the patterns are more easily applied to a revolving piece.

By Modelling, that is to say, the piece when finished may be further modelled with the hands. Edges of vases may be waved or crimped with the fingers, bodies may be flattened in or twisted to give them a grotesque appearance, &c.

By Building-up, as in the case of imitation basket-work or flowers. In the former case filaments of clay are pressed in a wad box through a metal plate pierced with the necessary sized holes, and woven or built up piece by piece in more or less the shape required, and then lightly pressed on to a plaster form to give them the requisite symmetry. Flowers may be made by making the leaves or petals out of moulds and afterwards sticking them together, or if they are required to be of very delicate form, very thin bats of clay and gum may be made, which can be cut and trimmed into small pieces and moulded with the fingers.

By Excision.—That is, by cutting out certain parts of the piece as indicated by marks in the mould, which may also be refilled with coloured clays.

By Perforation.—In the commoner pieces, such as soap and sponge grids or fish strainers, this operation is carried out with ordinary hollow metal punches, but if more elaborate effects are desired the piece must be cut through with a sharp, finely-pointed knife. The points at which the incisions have to be made are usually marked in the moulds. It is rather a difficult operation to satisfactorily accomplish, as, of course, if a piece is cracked or broken off, the previous work is valueless. Lozenge-shaped holes are some of the commonest in use and by no means the easiest to cut, and it is evident if one bar of this "lattice" work is broken nothing can

remedy it, and however far the work may be advanced it must be thrown aside as useless. Much attention must also be paid to avoid pressing the piece out of shape, and it must be remembered the more holes cut out the more fragile does the piece become.

By Etching.—Ware may be scratched with a graver, and any design almost may be thus obtained, and if clear patterns and clean lines are desired the ware must be fairly dry. If etched when wet the needle will form little ridges on each side of the lines. These ridges may be afterwards coloured with a tinted slip, thus forming an outline to the design. The best effects, however, in this class of work are obtained by dipping a light coloured body in a dark coloured slip, or *vice versa.* By this means the graver cutting through the film on the outside displays the pattern in the colour of the body beneath, thus greatly adding to its appearance. Pressed pieces may also have their details, such as lines, dots, rosettes, marked out in coloured slips.

Coloured Slips, both natural, that is coloured clays in their original state, or artificial, that is clays coloured by the introduction of metallic oxides, may be largely used for the decoration of clay ware. The pieces may be completely immersed in one colour, or the outside may be dipped with one colour and the inside washed with another. Or bands of colour may be formed, and this effect is generally produced with the assistance of the lathe. The coloured slip is poured into a bottle to which is attached, through the cork, a tube with a mouth-piece; the turner blows through the tube and forces the slip out of a spout in the bottle on to the revolving ware. In the same way patterns are first impressed with rollets and the coloured slip is blown into the depressions, any superfluous clay is then turned off, leaving the impressed pattern alone coloured. The

whole piece may be dipped in one colour and then rings and patterns turned off revealing the body beneath.

When a mottled appearance is desired the coloured slips are placed in a receptacle divided into separate compartments, all of which are connected by tubes with one common spout or tap When the tap is turned on they flow in one stream but do not mix together, and thus cause a variegated or marbled appearance as they flow over the ware, which is held underneath the tap and turned from side to side till completely coated. This is known as "Mocha" ware. The slips should all be of the same degree of liquidity to ensure equality in the covering. Tobacco juice, mixed with water and underglaze black, is sometimes introduced into the slip and produces an arborescent effect by allowing a drop or two of the liquid to run down the piece before the slip is dried.

By Engine and Rose Turning.—These have already been referred to in the notes on turning, but the ware must be drier than for the processes above described, and it can with advantage be made thicker than the ordinary run of ware to resist the pressure of the tools.

CHAPTER XII.

GENERAL REMARKS ON CLAY WARE.

CONTRACTION has already been mentioned several times in the course of these notes, and although firing, which is one of the causes of contraction, has not yet been discussed, it may be as well at this point to offer a few remarks on this most important subject, as irregular contraction is one of the most general causes of defects of earthenware as it is in all other ceramic productions. There are, roughly, three periods during which this action takes place.

Though the ware has already somewhat contracted in the mould, owing to the absorption of some of the moisture in the clay by the plaster, the *first period* may be taken to be from the time the piece leaves the mould, while still moist, until it is as dry as it will become in the air or stove and is in proper condition to go into the biscuit oven, that is to say, till the water which has been artificially added to the various materials to ensure a thorough mixture and to render them plastic and workable has been driven out, together with a portion of the moisture that was originally in them, more especially in the clays. As the water dries out of the mass the solid particles move closer together and the contraction or diminution of the piece commences and continues till the particles can make no further progress towards each other. This probably does not occur till early in the second period, though the point is reached before the mass is thoroughly free from water.

The *second period* is from the entry of the piece into the oven until the point when the particles will

begin to combine by heat and some of the component parts commence to vitrify. As has already been noticed, water in fine finished earthenware is non-existent, and therefore all moisture must be driven out completely, though at the same time slowly and gradually to avoid cracking. During this period, if the pieces have been thoroughly dried before going into the oven, the contraction that takes place is less than would be supposed, as, although the water is completely evaporated by the increasing heat, it leaves the mass porous and in a state of minute honeycomb, the different particles having already approached each other as nearly as they can. Up to this point the process of drying has been purely mechanical, and all the materials that have entered into the composition of the body are in the same state as that in which they were before being mixed, except that they, and more especially the clays, have lost the water which was previously naturally held in suspension in them. Thus far, then, the contraction is purely mechanical.

The *third period* is from the point at which the particles begin to combine, to that at which the highest degree of heat is reached and the firing finished. During this period a totally different set of circumstances come into force and the component fusible parts become vitreous, and the higher the temperature the more will they be affected and the greater will be the contraction till the point is reached when no farther contraction takes place. As earthenware bodies are usually very refractory, and the quantity of fusible material in their composition is kept very low, the contraction in them at this stage is very small compared to that of vitreous bodies. So the more vitreous a body, other things being equal, the greater will be its contraction.

In ordinary earthenware bodies the usual contraction

is about one-twelfth, or 8 per cent., though as already shown this will vary with its fusibility and the heat to which it is subjected. Contraction then depends largely on the moisture in the clay, and the greater amount there is in the clay during the processes of manufacture and the more plastic it is, the greater will be its contraction. The mode by which a piece is manufactured has also a considerable influence on it, and the more pressure that has been applied to the clay in making it the less will the contraction afterwards be. Thrown and turned ware as also machine-made pieces will contract more than pressed ware, and cast ware more than either, while articles made with metal dies by considerable pressure will contract least of all. And it is for this reason, as has before been noticed, that the union of parts of pieces made by different processes requires so much attention, and the more plastic the clay the more liable it is to defects from this cause.

Difference in pressure is the great cause of irregularity in contraction, for which reason the seams of a piece where the moulds join are always apparent, however carefully they may be trimmed and cleaned off. For with equality in pressure and regularity in thickness contraction is uniformly regular, and, should proof be necessary, take an equally and carefully pressed bat of clay of uniform thickness and cut it into a circle with a pair of compasses, and after it has been fired, with the same centre apply the compasses, and though the diameter is smaller owing to the contraction, the circle will be found to be as perfectly true as before the firing.

There is no better way of impressing on oneself the difference of contraction in the various materials used than by making a mould of the shape of a narrow tile or bar, say 6 in. $\times 1\frac{1}{2} \times \frac{1}{2}$ in., and from this mould

extracting a tile made from each of the materials alone, ball clay, china clay, flint and stone, just mixing sufficient water with them to form a mass that can be pressed into the mould. The flint will offer the greatest difficulty owing to its being without plasticity and having little contraction. When taken out of the mould the tiles or bars of the materials will be the same size. They should then all be fired in the same sagger in the biscuit oven. The difference in the contraction is very great, and once seen it will never be forgotten. The body mixture in use may also be moulded and fired at the same time and the contraction also compared.

It will be also as well to work out the proportions of the materials in the body in dry weight to obtain an exact idea of the quantities of the different materials really entering into the mixture—wet mixing being rather misleading in this owing to the different weights per pint at which the materials are used.

The principal causes of contraction in earthenware, then, may be said to be the coming together of particles which were previously prevented from so doing by the mechanical presence of water, which has been driven out, and the slight fusing of some of the component parts of the body. To which must be added the pressure applied to the piece in the course of manufacture.

It is noticed that the vertical contraction in some pieces, and especially high ones, is greater than that in the horizontal direction. This may be partly attributed to the weight of the upper part of the piece slightly compressing the lower, and thus assisting the closer contact of the particles in the lower part, and this is especially to be remarked in cast ware. Pieces are also likely to go out of proportion if they have more than one centre point of contraction, and therefore large and thick parts joined together by thin ones should

be avoided as much as possible, and it is therefore important in designing models that the contraction should be calculated to a common centre as near as may be.

Some of the chief defects in clay ware are as follows: cracked or crooked ware; improperly stuck-up ware; hollows or lumps in the pieces; difference in thickness and weight; difference in size, roughness, &c.

Cracked Ware may be caused by getting it too soon off the mould, or in certain shapes made on outside moulds by leaving it on them too long—or, of course, by rough treatment. If certain pieces are liable to cracks, when looking over the ware, it is as well to pass a damp sponge over the place where the cracks are likely to appear, and they at once become apparent, though in the white state the eye would have failed to detect their presence owing to the fine dust caused in finishing the piece when dry, with flannel, filling and covering them.

Crooked Ware may also be caused by removing it too soon from the mould, more especially in the case of "flat" or by bunging it too high, or from putting it to dry on crooked boards, or from pressing it out of shape during the operations of turning, fettling or handling, or from unequal drying, one side being drier than the other. This is likely to occur when stoves are heated by fires placed in the centre of them. It is specially necessary to notice that the covers of pieces, such as soup-tureens and cover dishes, fit and are straight. Handles of cups, &c., must not only be exactly upright but put on at the same level.

Improperly stuck-up ware will also exhibit cracks, due either to the two parts not being in the same condition of moisture when stuck together, or to the use of too much or too little slip, or to the different parts not being properly cut and adjusted.

Hollows or *lumps* are caused by moulds being worn, chipped, or defective, or by small bits of clay sticking to the piece which have not been removed, and which have been rubbed into the surface when fettling, or to inequality in the thickness due to irregular pressure.

Difference of thickness and weight may be caused by improperly set tools, by insufficient or too much clay being removed by the turners, or by want of care on the part of the pressers by working away the clay in one place and leaving it in another, which is also a fertile cause of cracks.

Difference in *size* caused, often by taking too much off the edge during the operations of fettling or turning. This requires strict attention. Nothing looks worse than a lot of presumably similar articles varying slightly in size or height.

Roughness is often caused by insufficient care in finishing a piece, or by the use of coarse sponges, or dirty water, thus leaving a coating of slip or slurry on parts of the piece.

The clay end is a most important one, and the foreman's duties are many and of great consequence. He is responsible for the "getting up" of orders in clay. This requires a good deal of nice arrangement to get through the various pieces and shapes required together, and to have suitable ware for the different parts of the oven always ready, so as not to cause delay in placing for the want of suitable ware. Both these points are of the utmost importance, the first because, should the order go through the oven incomplete, some of the pieces must remain behind for the next, while those that have gone on pass through their various processes, and on arrival at the finished warehouse have to wait there till the necessary pieces come through to enable the order to be packed and sent away, which, both from the

customer's and the manufacturer's point of view, is most undesirable. He should therefore keep a simple book which will show at any moment what part of his orders are actually made, and whether they are in the greenhouse or have gone into the oven. In the latter case it is useful to note in the case of specially urgent orders the date of the entry into the oven.

The second point is also most necessary, as for want of proper ware an oven may be delayed a day, and that day can never be caught up again by any amount of work. Time is indeed money in the commercial pottery trade. Ovens require time both to place, fire and cool, and a day lost cannot be recovered, as these operations, more especially the two last, cannot be shortened. He is responsible for the receiving and looking over of the ware, and has to see that it is properly made and free from defect or blemish, and for the counting of it into the "greenhouse". This is the name given to the store where the clay ware is received from the makers; it should be roomy, heated by steam-pipes, which can be used if necessary, and full of stillages, so that the ware can easily be moved in and out on boards. The biscuit placers withdraw the ware they require for the oven from the greenhouse, so it is desirable that they should be able to see at a glance what ware there is, in order to make the necessary selection for the different parts of the oven. All ware is looked over either before or on entering the greenhouse, and all defective ware is put aside, and the respective makers of it are called up in turn, the defects pointed out, which they remedy if possible, and if not possible, the piece is broken and deducted from their account.

The foreman settles with the men, that is to say, they are paid in accordance with his account of the

ware received without defect in the greenhouse, if the system is to pay "good from hand". In some potteries it is the custom to pay "good from oven", that is to say, the work is paid for after the firing—any defects in manufacture then become apparent, and the expert can at once tell if the defect is due to bad making or to improper treatment in the processes of placing or firing. But makers rarely admit that the fault is theirs, however apparent; and this system leads to continual disputes and unpleasantness, and though at first sight it seems a fairer and more advantageous system, as many defects in work are very difficult to detect before firing, it must be remembered that clay once fired cannot again be used, as its properties have completely changed, and though the work may not be paid for, the whole of the value of the materials is lost. Whereas, if every piece is looked over carefully before the firing, by far the greater number of the defects will be detected, the defective pieces can then be broken, the work is not paid for, and the *material goes back to the slip-house* to be re-made. The loss is thus reduced to the cost of re-making the clay, and the loss of time and cost of running the machinery, &c., in the making of the piece.

The foreman also gives out all the orders for making to the men, and in every pottery the system will be carried out in a different manner to suit the arrangement of its work. One of the best methods is for every man to have his book, in which his order to make is entered up, and when he counts his ware the quantity is marked off that he has made, and when the order is finished a fresh one can be put down. By this means, no matter how many men are at work it is at once known what each man is doing and how far he is towards completion of his order, and this is very useful if for some unforeseen reason a lot of work has to be suddenly executed,

as it can at once be seen what men can be taken off their present work and put down to the new. It also constantly draws the attention of the foreman to the regularity and producing power of each man, as by looking through the man's book he can see at a glance the amount of work he has been doing in the past weeks. The settling accounts would also show this, but they take some time to go through. Each man's book therefore becomes a record of what he has done and a memorandum of what he has to do, and there is no possibility of men making more than their order to avoid giving themselves the trouble of changing their tools, or of making mistakes in the quantity of each shape and size they have to make.

These little matters are very necessary for proper organization, as a man who is absent from his work where machinery is used causes much greater loss than would be the case where it is not used, as not only may it cause serious inconvenience by not having the work executed at the time required, but all the expenses of motor power, &c., are incurred the same whether his machine is running or not, and in his absence the machine is of course unproductive.

The foreman is also responsible for the proper filing and setting of the tools and for giving them out of the tool store as required. Each tool should have its number stamped on it, and a book should be kept giving particulars of its use, as sometimes a tool may be used for more than one shape. In many cases, especially when there are several sizes of the same shape, it is best to have the name and size also engraved or scratched on the tool, as some of them look so much alike that a workman may easily make a mistake when a new shape is first put in hand. It is also as well when pieces are made in several sizes to have the number

and size stamped in the clay. Stamps can either be made in pitcher or plaster though the former are the best as they last longer and make a cleaner impression. This is very useful in the warehouses as it diminishes the chances of mistakes in the sizes.

Every workman should also have his mark or number, which he should stamp on his work; by this means detects and imperfect work can be brought home to their originator without fail.

There are a multitude of small matters which will also require the foreman's constant attention He must examine his ropes from time to time so that any necessary repairs may be done out of working hours, and thus breakdowns are avoided, as it is not the half hour that the rope is stopped that must be taken into consideration, but the half hour that every machine on that rope loses, which may mean many hours of production lost unnecessarily. He should be most particular in the cleanliness of the shops and benches, and especially insist that all scrap clay that falls from the bench or machine on the floor is at once picked up and not trodden about.

Scrap clay should not be allowed in large quantities on the benches, but should be continually carried back to the slip-house or to the place appointed for it. Turners' shavings should not be allowed to accumulate under the lathes, but should be taken back to be re-made; at every week-end the benches and floor should be thoroughly washed and cleaned, and all machines and tools cleaned and oiled. The heads should be unscrewed and the spindles oiled and covered with inverted bowls to prevent dust working into the bearings, and whenever any sweeping in the shops has to be done, the floors should always first be sprinkled with water to avoid dust rising.

He should permit no filing of tools at the benches and only in the place specially appointed, and he should particularly note that the men when fettling their work use clean water and do not allow their jars to become full of slurry. This seems a small matter, but sometimes its results are far-reaching and most serious, as, apart from the likelihood of its causing dirty and discoloured ware, it is a common cause of peeling. He should see that moulds when finished with are returned to the store and not allowed to lie about the shop on and under the benches, where they are sure to get chipped and damaged, and some day when a few dozens of some shape are required it will be found that the moulds are not in the condition they were supposed to be, and the whole order perhaps has to be delayed till new moulds are made.

In fact the foreman should be continually round his shops seeing that the ware is being produced as required, and giving his special attention to any work in which there has been excessive loss in the past ovens, or to any difficult work, or to any new shape in hand, and to stop anything that is likely to lead to defective work, and nip it in the bud rather than wait till it is ready to carry into the greenhouse. In no trade is the proverb "A stitch in time saves nine" more applicable than in pottery. He cannot be too methodical in his work or too strict in having the rules and regulations of his shop attended to. Cleanliness and order in the clay shops are as important for the good conduct of the business as they are for the health of the work-people employed in them.

The foreman should be thoroughly in touch with the biscuit warehouseman in order to supply his wants, and before every oven is closed he should see if there are any odds and ends wanted to complete orders that he

can get in. When the oven is drawn and sorted he should go through the defective ware and note the reason of the defects, and if it is bad workmanship he should have the responsible person in to see it and explain to him how to avoid it in future; should it be due to any cause which he is unable to cope with himself he should at once call the manager's attention to it. By attending to these points faults are at once corrected and not allowed to slide on; and not only is it depreciation of goods, coming out seconds when with reasonable care they might have come out firsts, that must be considered, but orders are delayed owing to the biscuit warehouseman not having the necessary goods of the proper quality to complete them.

These seem small matters, and so they are unless they are neglected. The further the course of the manufacture is studied the more will it become apparent how absolutely each department depends on the one before it, and delay or mistakes in one department will most assuredly show themselves in the next. It may be during the next day or during the next week, but show themselves they will, and the carelessness or inactivity of one person in not doing his work exactly when he should on one day may throw the whole of a department out of work on another. So that it cannot be too earnestly insisted on that, when a system of organization has been decided on, every part of it should be carried out exactly in its right order and at its right time.

CHAPTER XIII.

OVENS AND THEIR CONSTRUCTION.

THE ovens are the most important part of the potter's plant, and it is on their successful management that the result of the business will largely depend. Good biscuit ware is absolutely necessary to make good glost ware, and yet if the glost firing is not up to the mark the ware will be inferior, no matter how good the biscuit may have been. It is on these processes that the ware depends for its solidity, brilliancy of appearance, and durability; and it matters little what care may have been bestowed in the potting, glazing, and decoration of the pieces if the firing is not satisfactory. It is in this department that more money is lost than in any other, and any time given up to the correction of defects, or to the lessening of breakage and loss in the ovens, is indeed well spent.

There have been many different forms and shapes of ovens in use for the firing of earthenware, but the *type* of oven to-day is very similar in nearly all manufactories, though there are considerable differences in the methods of working them, but on the whole there has been very little change in the methods of firing earthenware amongst the bulk of the manufacturers, and much the same systems are to-day adhered to that were in use a hundred years ago. The general type, then, of oven is circular and domed at the top, having much the same shape as the old-fashioned straw beehive.

The mouths of firing grates are situated at the circumference of the base, and the flame is divided before entering into the oven chamber, part of it passing

horizontally through the flues under the bottom of the oven, and eventually issuing from the well-hole in the centre of the bottom, the remainder rising through small chimneys or "bags" direct from the mouth into the oven chamber at the sides. The oven may be divided into three principal parts: the mouths, the flues, and the firing chamber. These may be said to be common to all earthenware ovens; but in the different parts of ovens there are various divergencies, and it is proposed briefly to refer to some of them.

Hobb-mouthed Ovens.—In these ovens the mouths project from the sides about 18 to 24 in., and the coal is fed into the mouths from the top through a square hole which can be covered with a fireclay quarry. This was the old-fashioned method, still however largely in use to-day, the idea being that by this means cold air could not so easily draw into the flues when "baiting" or putting in coal. The stack springs from the shoulder of the oven as a rule.

Hovel Ovens.—In this case the oven stands in the centre of a circular hovel, which rises to about the same height as the shoulder of the oven perpendicularly, and then arches or narrows over the oven like the shoulder of a bottle, the neck forming the stack to carry off the smoke. There is just sufficient space left between the outside of the oven and the wall of the hovel to wheel in the coal and to shovel it into the mouths. The advantages of this form of oven are that the mouths are protected from wind and currents of air, and that repairs to the oven can be executed with facility, as it stands detached in the centre of the hovel. The disadvantages are that the space round the oven is very confined for firing, the heat often being unbearable, and that the draught is sometimes rather defective.

Stack Ovens.—That is to say, with the ovens and stacks

built together. This is often the form adopted when ovens are grouped together under one large roofing, the stacks rising through the roof. Their chief recommendation is that they are solid and compact; but they have the inconvenience that when the mouths are first lighted they are apt to smoke and fill the shop with dirt, as there is no escape for the smoke backing out from the mouths, up the stack; they are rather more difficult to repair, and they certainly take rather long to cool down.

Down-Draught Ovens have come largely into use for biscuit, as it is considered that they are more economical in fuel, and that they can be worked to produce a more regular heat all over the oven; they are also generally used in firing firebricks. They are constructed in several ways, some with a chamber underneath the oven into which the down-draught flues run, and from this chamber a main flue is connected with a stack or shaft standing apart from the oven, the stack being used in common by several ovens. The flue to this stack is furnished with a door that can be opened or closed at will. The oven has also a stack like an up-draught oven, but with a damper on the crownhole that can be opened or shut by a lever.

The oven is started in the same way as an up-draught oven, but when it has sufficient heat in it the damper on the crownhole is closed and the door in the flue to the outside stack is opened, and by this means the heat is drawn down into the bottom of the oven by the flues, any surplus heat passing through the chamber to the outside stack. The name for this class of oven should be "up and down-draught", as the course of the draught is changed during the firing from up to down and down to up, according to the heat prevailing in the top or bottom of the oven. It must be admitted that the down-draught oven is scientifically the more

correct, as the gases and air have further to travel; they are thus more mixed together, as they pass among the bungs up to the dome and are there deflected down among the bungs again to the flues in the bottom, and the combustion is more complete. *Prima facie*, this, coupled with a diminished consumption of fuel, would indicate that this class of oven is the best, but it has to be taken into consideration that the first cost of down-draught ovens is heavier, both owing to the arrangement of the flues and to the extra stack outside, and that they require far more repairs, and that these repairs are more costly to carry out than in up-draught ovens. In fact it is often difficult to locate a stoppage in a flue without pulling down a lot of brickwork; added to this, they require more attention in firing. Messrs. Minton's and Roby's patents are reckoned some of the best in this class of oven.

These ovens may also be built with a big flue instead of a dome underneath, and also, to avoid the expense of an outside stack, a wide flue may be carried up the up-draught stack outside and joined into it above the damper; but the draught obtained by this means is not sufficient, and if several ovens are to be built on the down-draught system it would probably be cheaper to build an outside stack in connection with them all, and the working results would undoubtedly be better.

Bars.—It used to be, and still is in many places, the custom to fire biscuit-ovens from the ground, that is, without any fire-bars, it being alleged that there was thus more coal space, more room for clinkers and refuse during the lengthy time required to fire a biscuit oven (some 45 to 60 hours or more), and with bars it would probably be necessary to punch or cut out during the firing the clinkers that had been formed, and thus cold air would be admitted to the oven through the mouths,

which would crack and break saggers and dunt ware. Also in cooling, without bars the air had to pass through a big body of slowly dying fire, and thus the oven cooled far more slowly than if bars were used. In the latter case, the fire being smaller and soon dying down, the cold air would quickly obtain admission and thus cause dunted (cracked) ware, &c. But these inconveniences do not arise if care is exercised, and the combustion being much more perfect with bars, bars are gradually being adopted almost everywhere, both for biscuit as well as glost in all classes of ovens.

The Skeleton Oven.—This is an oven which of late years has become exceedingly popular, and it seems to combine all the best qualities of the different up-draught ovens. It is simple in working, easy to repair, clean, and it gives satisfactory results. It is proposed, therefore, to give rather a fuller description of it with some measurements.

As a rough-and-ready rule, biscuit ovens should be about 18 ft. 6 in., and glost about 14 ft. 6 in., interior measurement. These are nice, workable sizes. Biscuit ovens much larger than this, of 21 and 22 ft., and glost of 18 to 20 ft., will give fairly satisfactory results; but these very large ovens, though economical in that they will fire more ware with a proportionately less quantity of coal, require most careful attention to get a regular heat all over them, and the general consensus of opinion is against ovens of over 20 ft.

Large ovens take longer to set in and draw, and longer to cool, and for the general manufacturer, ovens that can be got quickly in and out are the best, as it is then easier to "get up" orders, and the packers are kept regularly at work as there are constantly ovens being drawn. The broad principle in the construction of a skeleton oven is that the stack is supported round

the oven proper by a series of arches, leaving between the shell or arches and the oven proper a space varying from 3 to 7 in. That is to say, the first 3 ft. of the oven and outside brickwork, up to the top of the mouths are built solidly together, but from this point upwards the oven proper stands absolutely independently and is not in contact with the shell. The advantages of this are, facility in repairing the oven, rapidity in cooling, and freedom from dirt, as the smoke from the mouths, when first lighted, passes up between the shell and the oven through the arches. The space occupied by the oven is small.

It will probably be best to give the measurements of an oven and afterwards to offer some remarks on its construction. For this purpose we will take as a type a glost oven of 14 ft. 6 in. inside measurement.

DIMENSION OF 14 FT. 6 IN. SKELETON GLOST OVEN.
Interior Measurements.

	ft.	in.
Width from side to side	14	6
Height from centre of bottom or floor to centre of crown or dome	17	0
Height from bottom at side to shoulder from which the dome arching starts	12	6
Height from bottom to top of brickwork of the bags	2	9
Height from fire-bars to top of brickwork of the bags	4	6
Width of bags inside brickwork at top	1	4
Depth of bags from front to wall of oven	0	8
Width from bag to bag, i.e., distance between the brickwork from one bag to another	2	4
Width of centre or well-hole in the bottom	0	9
Width of centre or crown-hole in the dome	1	6
The number of smoke-holes is 9, and their size (sq.)	0	3
(Placed about equidistant between the shoulder and the centre crown-hole.)		
The number of shoulder-holes is 9 (sq.)	0	3
The number of cooling-holes is 4 (about)	0	9
(Each fitted with damper and lever.)		
Trial-holes—the height from the bottom to the lower ones	1	3
the height from the bottom to the upper ones	7	0
Spy, or regulator holes—height from the bottom (passing through the brickwork of the bags)	1	7

	ft.	in.
The rise of the flues from the mouths to the centre	1	3

The number of flues running into the well-hole would be 9.

Exterior Measurements.

	ft.	in.
Height from outside floor to oven floor	1	9
Height from firing floor to shoulder from which the stack starts	17	0
Total width of shell of oven	20	6
Height from floor to top of stack	50	0
Width of arches in shell over mouths	3	0
Width of brickwork between each arch	3	8
Height of arch from floor to centre of arch	6	9
Height of arch from top of mouth arch	3	6
Clamins—Height to spring of arch	5	3
Height to centre of arch	7	0
Breadth halfway up outside	3	0
Breadth halfway up inside	2	9
Breadth at bottom	1	6
Iron arch supporting the stack over the clamins—		
Width	9	6
Height from level of fire-bars to centre of arch	11	0
Height from level of fire-bars to base of arch	9	9

Measurements of Mouths.

The number of mouths would be 9.
The number of flues from each mouth would be 3.

	ft.	in.
The depth of ash-hole below floor	1	3
Bars—Height from bottom of ash-hole (That is to say, about level with the firing floor.)	1	3
Height from top of bars to the bottom of the flue (But the bars should slope downwards and be at least one course of bricks lower behind than in front.)	0	11
Height from the bars to the top of mouth arch	2	6
Height from the bars to the top of Houster arch	0	10
Mouths—Width of mouth at bar level	2	8
Depth of mouth, back to front	3	6
Flues—Width	0	6
Depth (4 bricks)	0	11
Distance from mouth to mouth at bar level	5	0
Distance from mouth to mouth at bar level each side of the clamins	5	4

CONSTRUCTION.

Firebrick Work.—All brickwork in contact with the fire must be firebrick and never less than 9-in. work.

The joints should all be with fireclay mixed up with just sufficient water to make it workable; in fact the less the better. All joints should be made as small as possible, only using the clay absolutely necessary to lay the bricks in. Firebricks of various shapes and sizes will be required such as flat-backs $2\frac{3}{8} \times 5 \times 9$ for the medfeathers and mouths; ordinary size $2\frac{1}{2} \times 4\frac{1}{2} \times 9$ for general work. Arch bricks for mouths, bull-heads or wedged-shaped bricks for the oven crown, varying in thickness from $3\frac{1}{4}$ at the top and $1\frac{3}{4}$ at the bottom to $2\frac{1}{2}$ and $1\frac{1}{2}$, all being 9×4 in length and width. Split bricks 2 in., 1 in., and $\frac{1}{2}$ in. thick for places where it is necessary to reduce the height of a course.

"Oven bottoms," which cover the flues from medfeather to medfeather, are matched or grooved and tongued to fit into each other to prevent sand and dirt working into the flues. These are the most generally used bricks, though there are other shapes, such as large bag-bricks, regulator bricks, both long and short, circular bag-bricks, &c., which may be used with advantage. In firebricks, the very best are always the cheapest, as bricks that are soft and will not resist the heat may be the cause of heavy losses. The fireclay in which they are to be laid should be mixed with as much fine grog as possible, as by this means contraction is diminished, and this is the chief point to bear in mind in connection with all firebrick work. On no account should lime or mortar be used in any place that is likely to be affected by the fire.

Ordinary Brickwork of the shell and stack can be 9 in., strengthened where necessary up to 14 in., and in building the stack a manhole must be left just above the shoulder to enable the builders to get in on to the dome of the oven in case of necessity for repairs and clearing out the shoulder and crownholes. The stack

being built cone-shape gradually decreasing towards the top till it reaches the necessary height. The oven and ordinary brickwork are built together up to the top of the mouths, that is to say, 3 ft. 3 in. high from the firing floor, and up to this point the ordinary brickwork should be 14 in. at least.

The Space between the shell and the oven proper will be about 7 in., but between each mouth, or rather between each arch over the mouth, the shell is built with a rib or buttress inside from the foundation to the shoulder, making the brickwork 14 in., and leaving at these points a space about 3 in. between the ordinary brickwork and the oven. If considered necessary a brick or two may be tied into these buttresses from the oven at the shoulder.

Ironwork.—The "bonts", as the iron hoops that tie the oven together are called, should be $\frac{3}{8}$ in. thick and about 4 in. broad. About eight or ten of them will be necessary round the oven; there should be three or four of them close together or a few inches apart just under the shoulder of the oven, as this has to support the weight and pressure of the dome; the rest may be distributed about 1 ft. 6 in. to 2 ft. apart down the oven.

The bonts are in various lengths and joined by square rings, the end of each piece of bont being bent round the ring. It is as well that the joints of the different bonts should come in different parts of the oven and not one over the other. At one point in each bont the joint is made by turning up the two ends of the bonts at right angles, and a hole is drilled through each. Through these two holes is passed a bolt about $\frac{3}{4}$ in. thick, screwed at one end and furnished with washers and a nut; thus the bont, when placed in position, can be screwed up quite tightly to clip the oven firmly all

round. It is as well to leave bricks protruding from the oven in two or three place at the height of each bont to support it and prevent all chance of it slipping down should it become slack.

It will be found necessary when putting on a bont to hammer the bont into the oven wherever it bulges in order to screw it up closely to the brickwork. The bonts round the shell need not be quite so strong, and if they are 3 in. wide it will be found sufficient. Two bonts should be placed round the Houster arch below the baiting mouth and one above the arches in shell to hold them securely. One bont should be about half way up to the shoulder, which will just clip above the iron arch over the clamins which so largely supports the stack, and one below and one just above the shoulder where the weight of the stack comes. To keep the bonts in the shell in position it will suffice to drive a nail or hook or two in the brickwork under them.

The Arches in the shell should each be strengthened by $\frac{1}{2}$ in. iron, 3 in. wide, bent to the necessary shape of the arch and to the curve of the oven. At each side of the *Clamins* (as the entrance to the oven is called) is an upright piece of iron which may be either cast or wrought, bent to follow the outline of the clamins. It should be 3 or 4 in. wide and 1 in. thick, with a cross-piece of about the same size bolted on above the clamins, holding the two uprights firmly together; the lower ends of the uprights should be embedded in the brickwork, but to give greater rigidity, it would not be amiss to have the lower ends also bolted together by a cross-piece passing just below the top step into the oven To these two uprights are fastened the bonts which pass round the oven at the height of the clamins and which would otherwise pass across the clamins and stop up the entrance to the oven.

The uprights are fitted with sockets, which may be formed by some of the bonts where they are attached to the uprights, and into these sockets are fitted two iron ties across the clamins during the firing. They should be about 1 ft. 6 in. and 4 ft. above the top step into the oven. This increases the stability of the uprights and helps to resist the strain on the bonts, as in firing the heat invariably expands the oven a little, and it is for this reason the bonts are necessary. They should be looked to from time to time, as they sometimes burst and may injure the men attending to the oven.

Iron Arch over the Clamins.—As the clamins come between two of the mouths it would be very difficult to form brick arches in the shell over these two mouths and over the clamins as well, so an iron arch is used arching over the clamins and the mouth on either side. It therefore has to support a considerable part of the weight of the stack. The girder for this is made of two pieces of $1\frac{1}{2}$ in. iron $3\frac{1}{2}$ in. wide, bolted together about 3 in. apart. The two pieces must first be bent into the shape required, that is to say, they must be formed into an arch 9 ft. 6 in. across from foot to foot, the arch having a rise from foot to crown of 1 ft. 3 in. They must also be bent to the curve of the oven; that is, they must form part of the circumference of a circle 20 ft. 6 in. across, or the size of the outside of the oven shell.

The pieces of iron should be about 3 ft. longer than required, so that each end may be turned up 1 ft. 6 in. or so and bent slightly inwards to form feet on which the arch may rest, and which can be built into the brickwork. Under each of these feet iron plates 1 ft. wide and 2 ft. long should be placed to avoid all chance of the feet crushing the brickwork owing to the weight

the arch will have to support. The two pieces of iron can be drilled about every foot and firmly bolted together with washers between to keep them 3 in. apart, and they thus form a rigid girder of the shape required.

The height at which the foot of the arch will be built into the brickwork is, from the firing floor, 9 ft. 9 in., making the total height from the firing floor to the centre of the arch 11 feet. The floor from which the firing and placing are done is on a level with the fire-bars, and there are three steps up to the oven floor at the clamins, a total height of 1 ft. 9 in. The mouths on each side of the clamins should be placed as close to each other as the clamins will allow, to avoid upsetting the flue plan more than necessary.

Oven Bars are made in many shapes and sizes, but by far the most durable are old steel rails, or railway iron cut into the necessary lengths. They are rather heavy to move in and out of the mouths, but they last almost any time, do not bend, and leave plenty of space for the admission of air without allowing the fire to fall through them. Each length should have a hole drilled in the end, by which it can be more easily pulled out of the mouth.

BUILDING.

In building an oven a firm foundation is required; this is absolutely essential, as, no matter how carefully an oven be built, it will never give satisfaction unless the foundation is absolutely firm. An oven is exceedingly heavy, and should the foundation give over so little, the constant repairs required and the losses from flues breaking through and ovens drawing air, &c., soon mount up to many times more than the amount it would originally have cost to secure a firm foundation.

To secure a good and dry foundation for the bottom

of the oven it is necessary to take out three or four feet of soil and fill up solidly with broken bricks; this avoids the defect of the oven sucking moisture from the surrounding soil when firing. This foundation is called the Cork. The outer circles should be whole bricks, and when each layer of broken bricks has been laid, fine grog (ground up saggers or other fired material) should be riddled into the interstices and all holes should be filled up with broken shards. No wet material or clay should be used whatever, and only material that has already been fired and has thus had all the contraction taken out of it. As the cork rises to the height required it must be graduated from the side to the centre, giving the same pitch as the flues are ultimately intended to have.

When the cork has reached a sufficient height and the rise in it is exactly as required, fine fired sand or grog may be riddled on in just sufficient quantity to form a smooth surface on which the first course of fire-bricks can be laid which form the flue-bottoms; and they will therefore have the necessary rise from the mouths to the well-hole. When the foundations have been laid and the cork fairly started, the position and sizes of the ash-holes and mouths should be laid out in accordance with the measurements already given, and to secure absolutely circular building of the oven an iron rod should be fixed firmly in the centre of the oven cork; a flat board is then required about 3 in. wide, having a hole at one end to fit over the iron rod. The exact distance from the centre to the circumference of the oven is then measured along the board, and at that distance the board is cut to a point. It thus forms a radius of the circle and can be turned round the oven, every brick being laid just touching the point of the board; another board may be cut in

the same manner for the shell, and by this means the oven will be built truly circular.

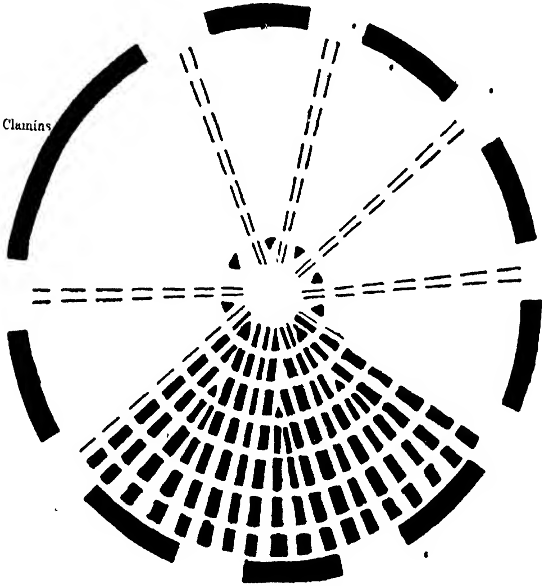
The Mouths.—In building the mouths the arches are made sloping slightly downwards, that is to say, each course of arch bricks is $1\frac{1}{2}$ to 2 in. lower than the course in front of it; by this means the flame is deflected down towards the flues. The feeding mouth may be furnished with iron doors or partly built up with firebrick, leaving an opening 1 ft. 4 in. wide and 1 ft. high, slightly arched; this is quite sufficient for baiting, and a fireclay covering brick can be placed in front of it. The latter system works best in the long run, as a broken brick is easy to replace, whereas iron doors soon get out of order and twisted by the heat, and are expensive to replace. The different parts of the furnaces are called—Regulator holes, Mouths, Gluts, and Ashpits.

FLUE PLAN.

The last and by no means least important part of the building of the oven is the arrangement of the flues. It is very easy to draw out on paper a flue plan which looks exceedingly pretty and which ought to work charmingly, but it is very difficult to work accurately to plan for the following reasons: In a plan it is easy to draw the medfeathers gradually decreasing to the centre; but when they have thus decreased, on what are the bottom bricks which cover the flues to rest? for they have to support the whole weight of the contents of the oven. The joints of the oven bottoms must therefore come well on to the medfeathers. There must in fact be a little give and take in putting in the bottom, and when it is put in it never looks quite so pretty as the plan.

It is best to lay out the flue plan with loose bricks on the cork, or at least one-quarter of it before starting

to build the flues; and here more than anywhere must it be insisted upon that the least possible moist material with contraction in it should be used.



FLUE PLAN OF 14 FT. 6 IN. OVEN.

White = Mouths and flues.
Black = Medfeathers and brickwork.

The middle flue, from the mouth to the centre, is built 4 bricks high. The cross flues are 3 bricks high, the fourth brick forming bridges across the flues, and thus giving better bearing for the natched oven bottoms. The well-hole ring may be supported on bricks on end, probably arch or wedge-shaped bricks.

The number of side flues between the mouths vary according to the idea of the builder—anything between 3 and 5 being suitable.

The great object in a good flue arrangement is to get sufficient draught to the centre, and yet, by blocking the flues in different places, to hold the fire in the bottom so as to work thoroughly through all the flues. It is therefore evident that much depends on the size of the oven, the pitch of the flues, and the draught or pull from the stack; the arrangement and height of the bags inside, and the quality of the coal used in firing must also be taken into consideration. Still, the more flues there are in the bottom the better, as long as it is not dangerously weakened. A flue plan is annexed, and it can only be said that it has given satisfactory results; but, as has been already remarked, what suits one oven may not suit another, and perhaps nothing varies so much as the rise required in the flues to obtain satisfactory results in different ovens, and the larger the oven usually the greater the amount of rise that will be required.

The medfeathers forming the flues and supporting the oven bottom are built four bricks high from the mouth to the well-hole, and they start at the mouth 4½ to 6 in. wide, decreasing as they converge towards the centre or run into each other, and care must be taken in cutting them away to leave sufficient support for the bottom. There should be three flues from the back of each mouth —the centre one running straight through to the well-hole, the remaining two gradually running out into the side flues. At each side of the mouth at the back a flue runs round the circumference of the oven into which the side flues work. The bags rise directly from the mouths into the interior of the oven. The ring round the well-hole is made of fireclay in two or more pieces, and should be about 3 in. thick and 6 in. wide.

A thorough repair and relaying of flues, oven bottoms, and bags (ridding) costs about £30, and an oven will

probably require it every three years, though this will, of course, depend on the work it has done. An oven's life is roughly estimated for commercial purposes at 20 years. There are, besides the ovens mentioned, many others that have been or that are in use in different countries, some fired by gas, others by oil; some two stories, others even three or four stories high, the heat passing from one stage to another.

Continuous ovens of various construction have also been tried, and no doubt under varying circumstances they have been and will be successful, especially when under the superintendence of those who have made a study of the construction of the particular oven and the methods necessary for securing satisfactory results, but so far none of them have come into general use, and probably the same ovens in the hands of people not thoroughly conversant with their peculiarities would result in complete failure; and it must be remembered that the firing of ovens commercially is not and never can be wholly in the hands of scientists, and cannot be conducted as an experiment would be, in a laboratory with costly appliances for verifying temperatures, &c. It is not as if an oven were fired only occasionally, as on works of any size there is always an oven, either biscuit or glost, being fired, and several firemen and sitters-up are necessary, as they require *constant* attention. If it were necessary to have a band of highly paid chemists to look after the ovens the outlook for the potter would be dark indeed in these days of keen-cut prices.

Firing to-day is for the most part in the hands of sufficiently skilled men, who are gradually, with the general advance of education, becoming more observant and careful in their methods, and are perfectly capable of managing the ovens in present use. At the same

time it must be fully admitted that they are very prejudiced against the introduction of new systems of which they do not at once see the advantage, and any difficulty or mishap is at once put down to the fault of the system and not to the way in which it has been worked, the latter being as often as not the true reason; and the failure of the new system is at once contrasted with the success of the old.

Apart from this, the ordinary manufacturer cannot afford to make the necessary experiments, as any experiment, unless made on a commercial scale, is absolutely valueless; there is nothing so misleading as to make experiments in firing on a small scale; systems often work wonderfully on a small scale, and when applied to ovens with greatly increased flue length prove quite unworkable. These trials on a small scale are usually made with the greatest care, with skilled assistants, and under totally different circumstances to those which they would undergo in the work of an ordinary pottery.

Almost every oven requires following differently, hardly two requiring exactly the same treatment; and to get the best results from an oven a man must have fired it several times to know its little peculiarities. If, then, a manufacturer wishes to start a new system of oven, it must be fired four or five times if he wishes to give it a fair chance before it can be decided if it is good or bad, as any defect may be due to his faulty method of working, and not to the system itself.

Suppose the result be bad, what manufacturer, apart from the first cost of building new ovens, can stand oven after oven coming out bad? Not only is it the loss of material and wages paid, but the loss of time and the inability to complete his customers' orders that must be taken into consideration. It is the scale on which experiments must be undertaken that deters many

a manufacturer from making changes, for it is not sufficient for him to know that such and such a system has been successful elsewhere; he must know the class of ware being produced, the body and the glaze employed, and the conditions under which the system is used. In fact, to start on any new system of firing, it is essential that the manufacturer should have personally seen the system he proposes to adopt successfully worked under similar conditions to those with which he has himself to deal.

There are doubtless cheaper and less wasteful systems in use than those employed by the English potter, which he could to-day use if he were prepared to change his mixtures and system of manufacture. But would that be a step in the right direction. It might cheapen his production; but would it improve it? There is little doubt that the majority would be against alteration in this direction. To obtain a more equal heat all over the oven is no doubt advisable, but it must not be lost sight of that different heats are required for different articles and different colours, and it would not be an altogether unmixed blessing if there was no variation of heat in the various parts of the oven.

These remarks are not intended to deter manufacturers from making experiments, but merely to point out that the cost of failure should always first be calculated rather than the profits of success.

CHAPTER XIV.

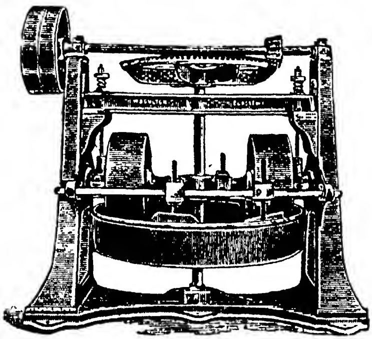
SAGGERS AND SAGGER-MAKING.

Before proceeding to placing and firing, the manufacturing of saggers must be referred to. Ware neither in the biscuit nor in the glost oven can be subjected to the direct action of the fire, and therefore all ware must be protected by being enclosed in *saggers*, which are fireclay boxes of various shapes and heights, though the most commonly used forms in modern manufacture are either round or oval, as it is found that these are the most convenient shapes both for filling with ware and for close arrangement in the oven. It is very necessary to have a large stock of saggers in order to always have suitable sizes in which the various ware can be placed.

Firing is probably the most expensive part of the manufacture of ordinary ware, and therefore it is of the utmost necessity that saggers should be thoroughly filled. To do this it is necessary to have a stock of saggers considerably greater than will suffice to fill the ovens, and the more general the trade the greater the number of saggers that will be required to ensure saggers of the various heights suitable to the different pieces. It is evident that if low ware is placed in high saggers considerable room will be lost and fewer saggers can be placed in the bung than if they were exactly of the height required by the piece.

Saggers are made of marl or fireclay and *grog*, which is ground-up biscuit, saggers, firebricks, and broken biscuit ware; in fact, any refractory material which has been already fired and has had the contraction taken

out of it. Glost saggers can be used, but should be introduced in small proportions, as, being glazed, the glaze would soften and fuse the mixture when refired. The grog should be ground up to the size of wheat or even to the size of peas if the clay used in the mixture is sufficiently plastic. It may be ground with heavy stone runners on a stone bed or in a pan-and-edge roller mill. The mixture of clay and grog will depend altogether on the quality and plasticity of the clay.



PAN-AND-EDGE ROLLER MILL.

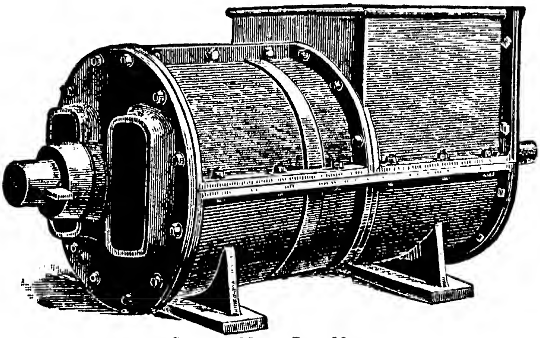
The qualities required in saggers are infusibility, strength, and stability, all of which mean economy, as the saggers can be used time after time and will withstand the constant cooling and reheating without cracking or splitting. Freedom from scaling or flying off is most important, especially in glost saggers, where it is likely to cause heavy loss. For this reason old glost saggers are very valuable, as they are thoroughly glazed and there is small chance of particles of the sagger flying off and sticking to the ware and spoiling it. This defect

may be caused by the presence of particles of quartz, iron, or lime in the clay, but as often as not it is due to a faulty mixture of materials.

Saggers should be kept in a dry place, and ovens should be cooled gradually to avoid excessive breakage. It is also necessary that the contraction in them should be small, and to obtain these results it is necessary that the mixture should be "open" to allow for the sudden changes of temperatures they have to undergo. The mixture for the body must depend altogether on the nature of the clay, and it is evident that the greater quantity of grog that can be introduced into the mixture, without interfering with the working up of the body into saggers, the better, keeping it "open". Some clays can be worked with two parts of clay to three of grog; some with even more; others with considerably less. Experiment alone can decide this, and no rule can possibly be given.

The contraction of the material must also be taken into consideration in arranging the sizes of the saggers. When the mixture has been decided on, a layer of grog is first placed on the floor, then a layer of ground clay, then another layer of grog, and so on till the pile is 1 ft. 6 in. to 2 ft. high. It can then be dug over and sprinkled with a little water and passed a couple of times through the pug-mill, which is similar in action to that described under clay-making, but is rather shorter and has two exits for the clay instead of one. It is better to pass it twice through the mill to ensure a thorough mixture. The less water and the stiffer the mixture the better; it means harder work in making, but it also means better saggers. Where machinery is used in mixing, the clay and grog are ground up together and the mixture is made with water in a blunger. When thoroughly blunged up it is run into a steam-jacketed

tank to drive off the superfluous water, and when of sufficient consistency it is passed through the pug-mill. The mixture to be used for the bottoms of the saggers should have more grog in it than that used for the sides. The sagger-marl when made is taken to the sagger-maker's shop and piled up in one place set apart for the purpose, and is beaten into a thoroughly solid mass with wooden mallets to give it greater consistency and strength.



SAGGER MARL PUG MILL.

The Appliances required by the sagger-maker are as follows:—

Benches, which are either of wood or with brick foundations, having wooden or iron tops to them; the latter are probably the best as they are more solid. On these are screwed strips of wood or iron of the thickness required for the sides of the saggers and sufficient distance apart to form the height necessary for those in most general use. Should smaller sizes be wanted it is easy to cut off the part not required with a knife

and a coarse ruler. The usual thickness of saggers when fired is about three-quarters of an inch, though very large ones should be thicker.

Iron Hoops, forming circles and ovals, of the thickness of the bottoms and rather larger in circumference than the finished sagger.

Drums, or shapes of wood, of all the different sizes to be made, on which the sides of the saggers may be formed. These should have a hand-hole in the top to facilitate their removal from the sagger during manufacture.

Square or Octagonal Boards in considerable numbers, suitable to the different sizes of saggers to be made.

Whirlers, which are usually square and made of wood, on which the sagger can be placed and turned round easily during the making.

A Small Iron Spade or Cutter, to cut off strips of clay from the solid pile of clay suitable for forming the sides

Tools.—A few pieces of stick, a knife, and a piece of cloth or two, and wooden mallets of various sizes. These will be all the requirements for the manufacture of saggers by hand.

Ample drying room will be required.

Small Saggers may be made by expression from a press, as drain-pipes are made, and afterwards may be cut in lengths and stuck to the bottoms with clay slip.

Large Saggers are sometimes made by machinery, the clay being pressed under rollers to form the sides. The clay is placed in shallow iron troughs of the depth required to form the sides, and then passed under the rollers, which press the clay firmly and smoothly into the form. The strips of clay are then removed and applied to the forms or drums, thus making the sides of the sagger. There have been many appliances tried

for making saggers completely by machinery, but up till the present they have not given sufficiently satisfactory results to come into general use, and by far the greater number of saggers are still made solely by hand. It will, therefore, be as well to briefly describe the process.

The sagger-clay, having been thoroughly beaten into a solid mass about the height required for the sides of the saggers, the sagger-maker cuts off a strip of the thickness and length desired with the spade-cutter. He first sprinkles a little dry sand or fine ground grog on the bench to prevent the clay sticking to it. Sand is always rather dangerous for this purpose, as it falls off when the saggers are fired, and in making glost saggers sawdust is sometimes used in preference. He then lays the strip of clay on the bench and beats it with a short mallet firmly in between the strips. By this means he forms a solid bat of clay of sufficient length to form the whole side of the sagger and of the same thickness as the strip of wood nailed on the bench. He then places the drum of the sagger on the bat and rolls it along, winding the clay on to it. The bat is cut off at the meeting-point and the joint is made by kneading the clay well together with the fingers and a little slip.

Meanwhile, the sagger-maker's assistant, of whom he generally has two or three, has taken a lump of clay prepared for the bottoms and has placed it on a bench inside the iron ring which is to form the bottom of the sagger. The clay is beaten out with a wooden mallet till it fills the space contained by the ring solidly, care being taken to beat it to the same thickness all over, and not to leave it thinner in the middle than at the sides. This is a serious defect, as saggers that are thin in the centre of the bottom are bound to give way when

filled with heavy ware. The work being finished, the iron ring is removed and the bottom is placed on a board; this is then placed on the whirler and the sagger-maker places the drum, surrounded by the side, on the bottom The bottom is rather larger than required for the sagger, and so projects a little outside the sides. He then makes a groove round the bottom outside by running a stick round the side; into this groove he pours a little slip and proceeds to knead the sides and bottom together with his fingers and thoroughly incorporates them. He then cuts off the superfluous clay and finishes off the joint clean with a piece of wet cloth as the whirler is revolving. The drum is then removed and the joint made good in the same manner inside.

The work being finished, it is removed to the drying room. Ample drying room is required, as it is very essential that saggers should go absolutely dry into the oven, or there will be heavy loss in split saggers. Considerable heat is required, as saggers are very thick, and must be dried right through; so if steam is used it is as well to have the pipes arranged with standards every few yards, so that they can be used as stillages for the saggers. After sufficient time has elapsed the saggers should be removed from the boards, as this facilitates the drying of the bottoms. The thicker and stronger saggers can be made the better, as long as they do not become too heavy to handle. Saggers should be dated when made. This is no trouble to the maker, as he just marks them with a stick when wet, and it is a useful guide as to the duration of saggers, besides facilitating the counting of work at the week-end.

Saggers are settled for in different ways, either by day wage, piecework, or by a fixed payment of so much per oven to keep up the saggers and a certain arranged surplus stock. This latter is by far the best method,

as it is to the sagger-maker's advantage to make as few saggers as possible. He therefore makes them in the best possible manner, and has always his eye on the placers and oven-men to see that they treat the saggers fairly, and do not throw them out when they might be used again. At first sight it would seem to be an equally good system to pay the sagger-maker so much per sagger made; but it would then be to his advantage to make as many saggers as possible. As, however, saggers are not sold, but only used in the production of the saleable article, the more saggers made the more material is used, and so the greater expense. Even if by a fixed sum per oven each individual sagger is costing more than the price that would be paid per sagger for piecework, the saving on the material used, owing to the sagger-maker taking special care over his work, will repay the manufacturer again and again.

The point that needs attention is to see that the surplus stock is fully kept up. This can be done by counting the stock every now and then, or by counting the saggers made weekly and comparing it with the return of the saggers broken and thrown out, which should be handed in weekly by the foreman of the ovens. It is thus easy to see if the sagger-maker is keeping pace with the breakages. By this means the percentage of loss both in biscuit and glost can be accurately ascertained, which is required for calculating the cost of production of the ware.

Apart from the duration of saggers, it is important that they should be well-made and strong, as if a sagger gives way in the oven in the lower part of a bung, the whole bung may come down and perhaps bring others in its train. And not only must the breakage be considered, but the falling saggers and ware may fill up

the bags and flues, and the whole of one side of the oven may be short fired and spoilt; or the fireman may not be able to draw his trials, and his firing in that quarter of the oven must be done largely by guess-work. It is very false economy to have too few saggers, but the breakage percentage should be kept as low as possible, as sagger-making materials are an important item in the year's expenses, and a difference of 1 or 2 per cent in the loss on saggers during the year represents a considerable amount. In fact, saggers should be looked after and as carefully counted as ware. Seven per cent loss in biscuit and six per cent in glost may be considered reasonable, but with care these percentages can be reduced.

SIZES OF SOME SAGGERS IN GENERAL USE.

(*Outside Measurements.*)

Common height, oval, 20 in. by 15 in. by 8 in.
Basins, round, 20 in. by 13 in.
Round plate, 14½ in. by 7 in.
Ewer, 20 in. by 15 in. by 16 in.
Cup, 20 in. by 15 in. by 4 in.
Common round, 20 in by 5½ in.

Basin saggers in glost are often made with the centre of the bottom cut out (ringers), leaving a ledge all round for the props or dumps on which the basins are suspended. By this means the lower half of one basin enters into the upper half of the next below it, and by this means more can be placed in the same space. Special pieces will often require special saggers, and every effort must be made to save space in the ovens. The cost of firing a common height sagger is taken as the basis of calculations of cost. All other saggers are calculated as being half a common height, twice or twice and a half, as the case may be.

Firebricks.—It is as well to make a certain number of firebricks of the different sizes required for use in the ovens and kilns, as they can be fired for practically

nothing in the biscuit oven between the bags. The space occupied by them would otherwise not be filled, as they can be placed where there is not sufficient room for saggers. Too many of them should not be fired in any one oven, as, being so solid, they require considerable heat, and they may be a cause of delay in firing the oven. They should always be thoroughly dry before going in. The mixture for the firebricks may be made in the same manner as that for saggers, but it should contain considerably more grog—three or four parts, or even more, to one of clay. This makes the bricks most refractory, and free from contraction, as the greater part of them is material already fired.

Wad clay may be made of a somewhat similar mixture to that used for saggers, but the grog must be finer—in fact, like sand. It is most important that it should have no tendency to crack and fly off—a defect usually caused by an insufficiency of sand in the mixture.

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flat would weigh some half a hundredweight—no light weight to move about with ease and care.

Placers will require two or three ladders of different heights, which should be made strong, and the top should be sufficiently wide to rest a sagger on, if necessary, and should be cut away behind in a circular form, so that it may rest securely against a bung of saggers. The benches on which the placing is done should be strong, and at the point where each man does his work two pieces of wood about $2\frac{1}{2}$ in. high and 2 in. wide and 7 or 8 in. long should be nailed, 6 or 7 in. apart. The sagger to be filled is placed on these, and the placer has thus plenty of room underneath for his hands when he lifts it off the bench to carry it to the oven.

Over the benches should be two or three tiers of pegs on which the boards with the ware can be put. Clay ware can be placed in the sagger one piece on another till it is quite full; the chief point to bear in mind is that the ware must be placed in such a manner that it will not become crooked during the firing; neither on account of its contraction nor on account of the weight of the pieces placed one on the other. "Flat" ware, such as plates, dishes, &c., should not be placed in very high saggers, as, if filled, the weight would be too great and the bottoms of the saggers would very likely give, causing the ware in the sagger to go crooked, and very likely breaking the ware in the sagger next below it.

In placing flat, the clay plates are bunged up on "setters", which are either thick plates made specially for the purpose, or "seconds" biscuit plates; that is to say, plates which have come out of the oven defective. The former are, however, the best, though the latter may be the cheaper method at first sight. A bed is first made in the setter with a little sand, finely ground up pitchers or calcined ground flint; but this latter

is expensive. This prevents the lower plate going crooked, and the other plates are then piled on it; the lower plate must not be too thickly bedded, or there will be no room left for contraction, and it is sure to crack. In many cases it is the custom to introduce sand between the edges of the plates by rubbing the hands full of sand lightly round the edges, as it keeps them from going crooked, but this is not absolutely necessary. A little sand may also be sprinkled on the top plate, especially round the border, to prevent it from rising.

10 in. plates	can be placed	10 to 12	high.
8 ,,	,, ,,	14 or 15	,,
6 ,,	,, ,,	18 to 20	,,

Cups should be boxed on one another edge to edge, which keeps them straight. They should be stuck together with a little moist starch.

Dishes are very liable to go crooked, and are therefore bedded up one on another with sand or ground pitchers. It is very important that the sand used for bedding ware should be quite clean and free from iron and all colouring matter, or the ware in contact with it will come out stained or spotted. Dishes require special saggers made for them according to their size. They should be made low, especially in the larger sizes, so that the dishes need not be placed more than five or six high. Smaller ones may be bunged up higher.

Pieces with Covers, such as soup-tureens, cover-dishes, brush-trays, boxes, &c., should generally be fired with their covers on them, otherwise it will be found difficult afterwards to fit them, as, should the covers be in a different part of the oven to the bodies, they may get a harder or easier fire than the bodies to which they belong, and, the contraction being different, they will not fit as they should. Pieces may always be put inside

soup-tureens, cover-dishes, &c. It is important that the bottoms of saggers should be level, otherwise pieces, especially those with delicate feet, may take the form of the bottom, and thus go crooked.

Basins may be bunged up or boxed with chambers inside, and soap dishes again inside the chambers.

Bowls are bunged up one on the other, with a small cup or egg-cup in the top one.

Ewers can have tall articles, such as candlesticks or brush vases, placed inside them.

It is very useful to make some small fancy articles or knickknacks which can be used to fill up odd corners in the saggers where nothing else will go. Insulators and small electric appliances are very useful for this purpose. They thus cost little to fire, as they are taking up space which would otherwise be unoccupied. When it is remembered that there are from 2,500 to 3,000 saggers in an ordinary biscuit-oven, it will at once be noted what a difference in the cost of production an extra piece or so in each sagger will make, and low selling prices can only be obtained by making combinations in the ware to thoroughly suit and fill up the saggers. It is evident that if several small pieces can be introduced into an oval sagger containing two bungs of plates, the cost of firing those two bungs of plates is reduced; and the same rule holds good in all firing operations. At the same time care must be taken that no pieces are *above* the level of the sagger-edge, or the next sagger, when placed in position, will crush them.

After it has been placed in the saggers, the ware must be arranged in the oven in the parts best suited to it, that is to say, in accordance with the different degree of heat in the different parts of the oven.

The parts where the greatest heat is will vary slightly

in different ovens. The hardest part of an oven is between the bags and just above them, and in the first ring just above the bags. The top is the next hottest, and under the bags is generally not quite so hot as the top. This applies to the first ring. The second ring is in the same proportion, but not so hot as the first ring, and so on to the centre; though in some ovens, just round the well-hole is a hard place. If there are many smoke-holes in an oven, the top of the first ring will not be so hard as it would be if the number of holes were less. Broadly, the outer circles get more heat, and so the bigger articles which better resist heat should be placed in these positions. Any pieces likely to warp should be put in the protected parts of the oven, this applies specially to pieces with feet, delicate centre-pieces, &c. As a rough guide, a list is annexed of the position of various ware in a biscuit-oven. A large oven (some 20 ft.) containing five rings and an arch bung is supposed.

ARCH BUNGS.

Under the Bags.—Stoneware, mugs, bowls, ordinary pressed jugs.

Above the Bags.—Common chambers, kitchen ware, slipped mugs, &c.

FIRST RING.

Under the Bags.—Tea-ware, saucers, mugs, baking dishes.

Five to seven saggers above the Bags.—Fire-ware, stone-ware, common chambers, servants' ewers, teapots, strong jugs, ordinary toilet.

Above the Bags.—Best toilet, strong cover-dishes, salads, big dishes, soup-tureens, and anything not liable to warp. (No articles with feet.)

SECOND RING.

Under the Bags.—Small plates and saucers, &c.

Above the Bags.—Sauce-boats, delicate soup-tureens, salads with feet, sugar-boxes, butter dishes, any superior ware, dessert ware, and things that require protection.

THIRD RING.

Plates of all sizes; but it is best to get in all the 10 in. and 8 in. plates in this ring if possible.

FOURTH RING.

Small plates, sauce ladles, small pots, sauce stands, &c.

FIFTH RING.

Candlesticks, shaving basins, knickknacks, &c.

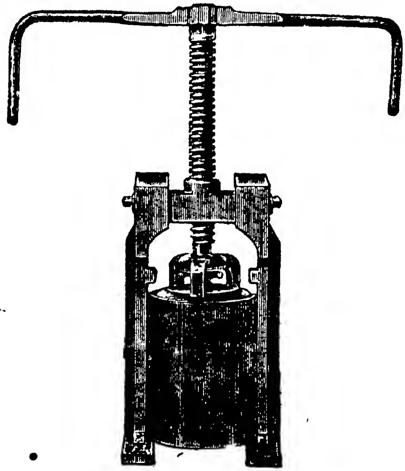
The ware having been placed, the sagger is carried into the oven. Great care should be exercised in the selection of the lower saggers of a bung, as they have to support the full weight of the saggers and ware piled up on them. Specially good saggers should also be chosen for the parts where the fire is directly playing on them just above the bags. It is very important that bungs should not fall and should remain as straight as possible, otherwise the normal firing of the oven will be interfered with.

As the bottom of the oven is sloping, and it is necessary that each bung of saggers should be run up perpendicularly, the lowest sagger is placed level on three pieces of brick, and care must be taken that these three bricks come on the joints of the quarries or oven-bottoms *over the medfeathers*. Should they be placed in the middle of the quarries, they are likely to break through into the flues, owing to the weight on them, and this again would interfere with the firing. It is not safe to run up one bung alone to the top, but several should be run up together; thus, if one does get out of the perpendicular the others will support it. A bung falling while being placed is most dangerous, and men may be hurt or killed by it. Great care should therefore be exercised; and even with the greatest care a bung may fall through one of the lower saggers giving way.

As each sagger is brought into the oven it is placed accurately on another, the bottom of one thus forming the cover of the one next below it, and the bungs are run right up to the top of the oven without touching it ("Crown's the mark," they say in Staffordshire),

including, of course, the green saggers, and in these saggers a few pieces of light ware may be placed, more especially round the sides, care being taken that there is not sufficient weight in the centre of the sagger to warp it.

The bungs should, as a rule, run from bottom to top all of the same sized saggers (though of any height);

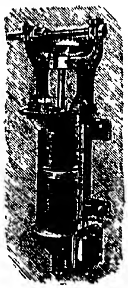


WAD BOX.

large saggers, however, may be placed across two or three bungs when necessary; but it would certainly be better to have a complete bung of the large-sized saggers if suitable ware can be found to fill them. After one sagger is placed on another, it is usual in England to take two handfuls of sand and rub them round the joining point of the two saggers to keep them thoroughly

closed, and to prevent flame or sulphur entering to discolour the ware, and at the same time it prevents the saggers adhering to each other. In many places on the Continent, and elsewhere, it is the custom to wad the saggers as in glost; that is to say, thin rolls of fire-clay made from a wad-box are placed round the edge of the sagger, so that when the next sagger is placed on it an air-tight joint is made, through which no flame or smoke can pass.

If the two systems are dispassionately discussed, the advantage will be found to be all on the side of the foreign system. At first sight the English method seems the cheapest, as it takes less time and trouble; but as the edges of the saggers get chipped and broken, they do not fit truly on each other, and the weight bearing unequally is a frequent cause of broken saggers and fallen bungs. The sand also often falls off if a bung moves ever so slightly, thus leaving admission for the flame to discolour and flash the ware. The sand also is constantly falling down, both when firing and drawing an oven, and filtering into the flues, which either stops them up and causes the oven to fire badly, or necessitates the continual opening of the bottom to clean out the side flues. On the contrary, if the saggers are wadded, each sagger fits firmly and truly on the other; the weight being distributed equally there is small chance of a sagger breaking, and it is in fact quite a rare occurrence to have a bung down or even out of the perpendicular. When biscuit saggers are wadded, however, the ware must go in very dry, otherwise, as the heat increases, steam would be



VERTICAL WAD CLAY BOX.

generated, and having no escape, the ware would be "mortered", that is to say it would lose its shape, collapse, and become merely a lump of clay again. There is no falling sand to stop up flues, and no flashed ware, and sanding flat may be dispensed with. Finally, the percentage of defective ware from the oven, when drawn, is considerably lower.

Saggers, when wadded, should have the edges brushed with calcined bone slip to prevent them sticking together, which facilitates drawing and decreases breakage. Bungs may be steadied with a half fire-brick wedged in between them in different places ; it is, however, far better to build the bungs as close together as possible to support each other, and to use as few brick wedges as possible, as they are liable to drop out, and this may entail the fall of more than one bung. No matter how close oval or round bungs are placed, there will always be plenty of room for the circulation of the draught and fire. If a bung is steadied against a bag, the half-brick should be placed against the corner or angle of the bag, and never in the middle, as, should the bung move ever so slightly, it will then crush in the bag and sadly interfere with the firing.

Nothing destroys saggers so much as too rapid cooling, and unless a biscuit oven is immediately wanted it is far better to leave it to cool at least two days, which will mean pounds saved in saggers. It is best to fire green saggers in the biscuit oven, as the heat is raised more gradually ; in the glost oven, where the heat is got up quickly, the saggers are more liable to crack, there being always a certain amount of moisture in them. It is, however, in practice, desirable to make each oven keep up its own saggers, as it makes the men careless if they are allowed to run off to the biscuit oven and take saggers whenever they are required.

Saggers sufficient to keep the glost oven going can perfectly well be fired one or two if necessary on each bung, and they will come out quite satisfactorily if they are sent in *thoroughly dry*. It is as well not to put green saggers on the arch bungs, as they are liable to be damaged ; the top sagger can be covered with an old crooked one to keep the dirt and flame from the ware. It is as well to bridge the green saggers from bung to bung on the top, as it helps to steady the bungs and keep them straight.

If the new saggers come off the top of the bungs "blibbed", or with black blisters both outside and in, it is a sign that the oven has been started off too quickly and over-baited, though it may be sometimes attributed to the use of inferior sagger clay.

Well-hole Pipes are like short drain pipes, and are used to carry the flame rising from the well-hole up to the crown-hole, like a chimney. If the bottom is very high pitched, and the oven fires very hard in the centre, it may be necessary to carry them up to the top. If it is a slow oven in the centre, they are hardly required at all. They are, in fact, used to protect the ware and have no effect on the draught. These remarks apply more to biscuit ovens ; in glost it is always as well to run them part of the way up, if not all.

Clamins should be built up two bricks thick to above the lowest trial hole, or to about the height of the bags inside the oven. And the rest may be built up one brick thick before firing ; but it is as well not to lute the upper part till the oven has been going eight or nine hours, as another means of escape for the moisture is thus left. The mixture for luting may be made of earth or sand and water mixed with a little clay or dung ; in fact, anything that will prevent the air drawing into the oven through the bricks. The top bricks should be

wedged firmly in with "cutters" or pieces of broken sagger to prevent any movement. When the placing has been finished, any ware over should be carried back to the greenhouse, and the benches should all be tidied up before firing commences.

The best way of paying for placing is by the result of the oven; that is to say, a price should be arranged at so much per dozen for the ware delivered into the biscuit warehouse, as by this means it is to the placer's advantage to get as much ware into the ovens as he can. Any ware that is broken in placing or drawing by their carelessness, would, of course, be deducted from their account. Sometimes the price is arranged with the fireman to include firing, then any pieces defective through bad firing, or any short-fired ware, should also be deducted. A biscuit-placer should be able to place eight to nine bungs a day, and so, by counting the number of bungs in an oven, it is easy to calculate how many men should set in an oven in a given time. The number of bungs placed will depend also on the class of ware and the distance which the men have to carry it. Roughly, it takes one-third longer to set in than to draw.

CHAPTER XVI.

BISCUIT FIRING.

After an oven has been drawn, the fireman should make a careful inspection, as there are always some small repairs necessary after each firing, which, if left until after the next firing, might make very large repairs necessary, or might even be the cause of considerable loss during the firing.

First, he should examine the bags, and if they are not sufficiently bad to require rebuilding, they should be stopped and fettled with fireclay. If an oven is in hard work, one bag will probably want rebuilding after every firing, and should the casing at the back of the bag require repair, the opportunity should be taken of doing it when the bag is down.

Second, he should see that the floor is in good order, and that no quarries have been forced down into the flues. Should this be the case, they must be replaced, and it may also be necessary to have up a quarry or two to see that the side flues are clear and not stopped with sand.

Third, he should make sure that the shoulder-holes and clearing holes in the crown are cleaned out, as they often get gradually stopped up with sulphur, &c.

Fourth, he should examine the foundation from which the arches of the mouths spring, and if the brickwork is much destroyed it should be cut out with a chisel and replaced with fresh firebricks. He should also notice that all clinkers have been thoroughly cleaned and cut out of the mouth, as, if they are left, they may be the cause of short-fired ware in the next oven.

Fifth. he should see that the flues are all clear from the mouths to the well-hole. This he can do by putting a piece of candle lighted in the well-hole and then looking along the flue from each mouth in turn.

By attending to these matters, the fireman is sure, at any rate, that his oven is in a proper condition to fire, and any irregularity he may notice during the course of firing cannot be attributed to any defect in the oven itself.

Pottery, without exception, requires, or at any rate is not injured by an oxydising fire, which is the most economical form of combustion, since all the gases are completely burnt inside the oven, and there is no waste of fuel. The fireman's object is to be economical in fuel, while obtaining the required heat in the different parts of the oven. He should be able to keep it a certain time at that heat if required, and must therefore be able, if necessary, to keep one quarter of the oven back or push forward another. This is managed by sending in a certain amount of air by the regulator holes, which are closed or opened as circumstances may require. To work an oven successfully, it is then essential that the fireman should know the heat which he has attained in the different parts of the oven, and to gauge this he uses trials or pyrometers of different sorts, which he can draw out of the oven or look at from time to time. A pyrometer, according to Brogniart, should unite the following properties:—

1. It must be easy to manipulate.

2. It must show the heat in the part of the oven where the ware is being fired.

3. It must show the heat at any given moment.

4. It must show with accuracy the changes in temperature.

5. The results must be accurate, and must be the same under all circumstances and at all times.

By no means an easy combination to arrive at!

The first point mentioned is one of the most difficult, as most of the means proposed for measuring the high temperatures required are too complicated for commercial uses; while those which are easy of employment are not absolutely accurate. Reference will be made in due course to some of the different varieties of pyrometers and trials.

A matter which the fireman should himself attend to while the oven is being placed is the position of the trials, and he should be satisfied that they can be seen and drawn out with facility. They are generally placed in the first ring in a sagger with a piece cut out of its side. This sagger must be placed exactly opposite and at the same height as the trial hole. In order to draw out the trials the iron drawing rod must be passed through the arch bung, and so in this bung a "draw thro'" or empty sagger with a hole cut in each side must also be arranged exactly opposite the trial hole through which the drawing rod can easily be passed. Care must be taken in cutting out the sides of the sagger for the draw through that sufficient strength is left for the support of the saggers that will be placed above it, and an especially thick and strong sagger should always be chosen for this purpose. If these matters are not attended to by the fireman personally, some day, sooner or later, he will find a mistake has been made in the position of the trials and in one quarter of his oven he is unable to draw them, and so he has no trials to guide him in the firing of that quarter of the oven. Or the trials may have been forgotten altogether and never have been placed in the trial sagger. In either case the predicament is awkward.

There are several sorts of trials in general use, the most common being little rings of red clay, which have

already been fired in clay state at a low heat. They should, when fired in clay state, be buried in flint and the sagger should be carefully wadded, so that the flame cannot possibly flash them, and they should be fired in the second sagger of the third ring of a glost oven. They are dipped in glaze of a composition varying with the taste of the firemen, some using four parts lead to one of flint; others four parts lead to one of stone, and all sorts of combinations of these materials. The mixture matters little as long as the fireman always uses the same and knows the effect of the heat on it.

These trials should always be put in a glost trial sagger, on a piece of glazed shard. As the heat increases the glaze melts and the rings gradually change colour, going through all the shades of deep red and brown till they become black. This form of trial is, however, only suited to glost ovens, or biscuit ovens where only a comparatively low degree of heat is required. In firing fine earthenware in biscuit, they are not a sufficient guide, as once turned black they show no difference in tone, and they arrive at this colour before the heat is sufficiently great to produce really good biscuit from a hard body. They may, however, be used as a guide up to a certain point, other trials being used to finish the oven.

The fireman keeps a set of trials from both bottom and top which he considers are of the exact colour required, and he compares the trials drawn from the oven with them, and he is thus able to gauge the heat at which the oven has arrived. The trials when drawn are dropped into a receptacle of water to cool them, so that their colour can at once be compared. Trials, of whatever sort, should always be drawn in the same order, and kept in that order on the bench or in a plate, so that the next round drawn can be placed by the side of them and compared.

Another form of trial, which is more generally used in the firing of large biscuit ovens at a great heat, is the "pitcher" trial. These trials are simply pieces of clay ware, such as bits of broken clay plates with a hole cut in them by which they may be taken out of the oven with the drawing rod. They are drawn from time to time when the oven is sufficiently advanced, and are broken with a hammer, and when cool should be taken to a dark corner of the oven-house with a candle (in order to always have the same class of light both by day and night) for examination.

The mode of judging the condition of the trial is to look along the edge of the fracture in a line with the light. If it has a rough and porous appearance it is not sufficiently fired. Breaking it with the fingers will also be a guide as to its hardness. If, when broken, it has a rough appearance in one part with a smooth appearance where it has broken in a zigzag form, that also shows an insufficiency of fire. When fully fired and up to the proper degree of heat, the fractured trial should have the smooth appearance, almost like cut cheese, and should be slightly shiny or glossy, though this appearance will vary in accordance with the composition of the body. Pitcher trials should be leant against a brick placed on edge in the trial sagger, as this greatly facilitates their withdrawal from the oven. If by any chance trials have been left out of the oven altogether, it is as well to warm up some ring trials and put them in the oven with the drawing rod, as they will always be some help to fire by.

Probably the most useful form of trial is by gauge. This was introduced by Wedgwood, and is founded on the property of the contraction in plastic clay. It is, however, little used outside England.

The gauge consists of a piece of metal in which is

cut a deep flat groove, the width of the groove diminishing gradually from one end to the other. The metal is graduated with lines or degrees each side of the groove. Little clay "bits", or half cylinders, are made to fit in up to a fixed point, and as the clay bits are fired they contract, and when placed in the gauge slide further up the groove, and by this means the heat is measured. The clay "bits" should be fitted in the gauge before use as accurately as possible, and the zero point should be marked on them by cutting a small nick across them at the O point in the gauge. This nick thus becomes the index for reading the degrees on the scale. It is very necessary that the bits should always be of exactly the same degree of dryness when they are tried in the gauge, as, should the humidity be different, the contraction will also be different and the result will be inaccurate; and for the same reason, in their manufacture equal pressure must be applied.

It is evidently important that the bits should be made of a body that will always have the same contraction and will also contract fairly equally as the heat increases. The latter is impossible to obtain absolutely, as clays always contract in jumps; that is to say, they often go through a considerable increase of heat without contracting, and then with a small addition of heat will contract considerably, and the contraction is usually larger at the lower temperatures than at the higher. This is not of very much moment when the fireman once knows the contraction of his "bits", and the points at which the chief contraction takes place; but it makes the system quite useless for comparison with other degrees of heat. Each manufacturer makes his own clay for "bits", and many different widths of gauges are in use; so that ordinary comparison of the heats to which different manufacturers are going is impossible.

The annexed table will give an idea of the contraction of clay "bits" drawn from the top during the firing, though, as already stated, the contraction will vary, with every different mixture of clay used. The clay bit is supposed to have been fixed at the O point—

After	22	hours'	firing	it slipped up	the gauge to	the 1st	degree.
,,	25	,,	,,	,,	,,	3rd	,,
,,	28	,,	,,	,,	,,	6th	,,
,,	31	,,	,,	,,	,,	26th	,,
,,	34	,,	,,	,,	,,	29th	,,
,,	37	,,	,,	,,	,,	35th	,,
,,	40	,,	,,	,,	,,	36th	,,
,,	43	,,	,,	,,	,,	40th	,,
,,	45	,,	,,	,,	,,	48th	,,
,,	49	,,	,,	,,	,,	53rd	,,

In practice, however, trials would not be drawn every three hours, but only when it should appear necessary. It should be noted that the top trials will always be harder fired than those at the bottom.

The adversaries of this system also allege that in accordance with the firing being quick or slow, the contraction of the "bits" will be different at the same degree of heat. Still, once the composition of the "bits" has been made, and the degree to which they are to be made to contract has been decided on, the system works quite sufficiently accurately for the commercial potter. The bits, when placed in the trial sagger, should be buried in small cups filled with ground flint, so that they may not be flashed. All trials of whatever sort should be destroyed as soon as the oven is drawn, as should they remain by accident in the trial sagger they may become a source of great perplexity to the fireman in the next oven that is fired.

Dr. Segar's chemically prepared cones are also used for firing by some potters. These are prepared so as to collapse on reaching different heats, and, by having a series of them in the oven, they collapse in turn as

the heat increases, the last one collapsing at the highest heat to which it is wished to go, and the firing is then stopped. Other trials, based on the melting point of different alloys of gold and silver, have been tried, and on the expansion of platinum wire and other metals have also been experimented with, but have not come into general use. About ten trials should be put in each quarter of the oven, four below and six in the tops; it is always better to have a trial too many than one too few.

Trials are most useful guides; but it is not merely necessary in firing to get up the trials to the necessary point, in fact, under some circumstances it is impossible to do so, owing to the falling of a bung or the breaking down and stoppage of a flue in one quarter; and if a fireman, under these circumstances, were to attempt to get up the trial to the degree of heat stipulated, he might melt down the rest of the oven to a solid mass, which would have to be broken out with pick-axes. There is no occasion to draw a trial during the first thirty hours, as the look of the oven and the way the fires are working will be quite sufficient guide. After this time has elapsed a round of trials should be drawn, as it is as well to make quite sure that no part of the oven has got much ahead of the rest, as should one part be ahead, it is better and easier to correct it then than later on.

It is generally necessary to keep back the tops, as they are almost always ahead, and should they be behind, it is an easy matter to get them up; whereas if the tops are already up while the bottoms are behind, it is no easy matter to get them up without increasing the heat in the tops, and once one part of the oven gets ahead, the heat, increasing the draught in that part of the oven, will keep on augmenting until it is almost

impossible to keep it back level with the other parts. Great care is therefore necessary whenever one quarter gets ahead, and it should at once be attended to. A great deal is often made of "soaking", and many firemen will say that ware has had sufficient fire and is safe if it has had a good soaking—meaning that it has been fired for a long time. Once the requisite heat has been obtained the oven may be held at that point and soaked a little, but so-called soaking before the full degree of heat has been reached is quite useless and simply a waste of fuel. In fact, if the ware has gone *thoroughly* dry into the oven, the sooner you get up the necessary heat the better, as long as the firing is not irregular and flashy.

A fireman judges as much by the working of the oven, the flame issuing from the crown-hole, and the colour of the heat, as by the trials; and it is as well to have some bricks made with round holes in them lengthways, in which a piece of glass can be inserted. The bricks can then be placed in the spy-holes, and by this means the colour of the oven can always be seen without withdrawing the brick and admitting the cold air. This is, however, not really necessary, and is more applicable to enamel kilns. The colour in a biscuit oven begins to show in about twenty-five hours, and the flues will then be getting red about two feet up; after thirty-four hours it will begin to get a brown-red all through. After forty-five hours it should be a brilliant cherry-red, gradually getting to a whitish-red at the end of the firing, say fifty to fifty-five hours. Time, however, is not a good guide to fire by, as a variation in coal, or a change in the wind, or the state in which the ware has gone into the oven, may make a difference of several hours.

When the oven is placed, the mouths are lumped with

coal ready for lighting. Five or six big lumps should be put in each mouth and a shovel or two of small coal, filling the mouth about half up. Old plaster moulds can first be put on the bars before lumping, as they do not interfere with the draught, and certainly protect the bars. To light an oven an open circular fire should be built with lumps of coal, ends outwards. It should be built up into a hollow cone or funnel till there is just room left to put in some paper or straw and sticks to start it; then, after lighting, lumps of coal should be built on till the aperture is closed. The cone should be about 2 ft. 6 in. high and about a yard in diameter. It will take about an hour to get well alight, and then it can be knocked down, if it has not already fallen, and a couple of shovelsful put into each mouth of the oven will light them up all equally and at the same time. This not only saves time, but is a much better method than lighting each individual mouth with sticks and straw. A big oven of 20 ft or over will take from forty-five to fifty-five hours to fire, and will consume from seventeen to twenty-two tons of coal, though the quantity of the latter will depend a good deal on the quality used.

Burning small coal or a proportion of slack means more care and attention, besides the extra time in firing. It may also make it necessary to punch—that is, to cut out the clinkers formed over the bars, which impede the draught, and this should always be avoided whenever possible, as it admits a large amount of cold air into the oven, and consequently retards the firing. What is required in pottery coal is long flame which will travel well to the centre of the oven. Heat lays hold of a small oven quicker than a large one, and a large oven should be allowed plenty of time at starting, especially if the clay-ware has gone in green, or if there

is a large amount of flat in the oven. Flat lies so very close together and is so solid that it requires a considerable time for the heat to get right through it; but if the ware is absolutely white dry the oven can be followed faster. Big ovens are generally more difficult to fire than small ones, as the fire weakens, travelling a longer distance through the flues. Towards the end of the firing, however, they sometimes come up very quickly, with quite a rush indeed, owing to the great body of heat in them.

In the first twelve hours about two tons of coal (not taking into account the lumping) will be burnt, about one hundredweight being put into each mouth at an interval of four hours; afterwards it will be necessary to bait at shorter intervals, say every three hours or less, with an increased quantity of coal. All the mouths should be baited regularly in order that the draught is equal in all.

Putting on too much coal at a time is a mistake, and smoke continually issuing from an oven shows bad firing and waste of fuel. The gluts should be left open for a couple of hours after starting, and then the front of the furnace, from the bars to the arch, can be built up with bricks, which prevents the fire from falling out, and also saves the fireman's shins. Sufficient space should be left between the bricks for draught, and a hole should be left at the bottom to put in the baiting poker to move the fire on the bars if necessary, but the less the fires are pulled about the better.

The tools a fireman will require are: a baiting poker about 6 ft. long and 1 in. thick, a punching poker of the same length and $1\frac{1}{2}$ in. thick. They are best made of steel, or, at any rate, pointed with steel, and should be kept quite sharp for cutting out clinkers. A drawing rod for drawing the trials, with the end well turned

up into a hook, so that the trials will not fall off; a heavy rake for pulling out clinkers; a barrow, a bucket, a couple of shovels, and a ladder of suitable length for drawing trials, and having a ledge on the top sufficiently broad to allow of his putting the brick drawn from the trial hole on it. These will fulfil all ordinary requirements. The mouths should never be filled up with coal till the oven has been going some eighteen hours; they should, in fact, never be really coaled up to the arch, as the flow of air is stopped and the best part of the brickwork, *i.e.* the arches, will suffer, and a pound's worth of damage may be done in a few minutes.

The difficult time in biscuit firing is about twelve hours from the end, and *the* point is the last baiting, which is two or three hours from the finish. After about thirty-five to forty hours' firing, should, on drawing trials, the top be found too far forward, air must be admitted by the regulator-hole under the arch; should it be behind, less air must be admitted, and regulators and covering bricks must be closed. Should the brickwork be white-hot, delay baiting a few minutes till the heat is rather reduced, then bait up and fire hard to reach the top.

When the time comes for the last baiting, and there is a doubt as to whether it should be a full one or a lesser one, and a full one is decided on, draw trials when it is half burnt off; then, if it is found that the heat is getting too great, and that the trials are fully up, a little sand may be thrown into the mouths, which will effectually stop the fires and the heat. Should at any time during the firing the heat get excessive, and the brickwork begin to suffer, and neither letting in air by the regulators nor using moulds will keep it down, a plateful of sand thrown into the mouth is

sure to be effective. When the brickwork begins to run like treacle, it is always a sign of excessive heat, probably caused by an insufficient admission of air. After the last baiting the mouths should be stoppered up with the covering bricks as soon as possible, to prevent cold air from too rapidly drawing into the oven, especially when there are big dishes, &c., in the oven.

In a biscuit oven the fires should never be drawn, but should be allowed to burn themselves out. It should not be disturbed for at least twenty hours after the firing is finished, when the top of the clamins may be opened. The mouths should not be punched nor the clinkers cleaned out till about thirty hours after the firing is finished. Ovens, however, must not be left longer than absolutely necessary, or additional ovens would be required. An oven that pinches or warps ware in the centre, and cannot be controlled by ordinary means, may sometimes be cured by putting a brick in the well-hole. This, however, is not a very safe proceeding, as it may be found too drastic a remedy, and it is, of course, impossible to take it out again while firing; it would, perhaps, be safer to put a brick in two or three of the centre flues in the mouths, and these can always be moved during the firing if the draught is not strong enough to the centre.

Before firing a new oven, or an oven that has not been in use for some time, it is as well to light a fire of about a ton of coal in the centre of the oven, having first covered the well-hole with some bars, and then distribute about a ton and a half of coal in the various mouths, and light them also, and by this means the oven will be thoroughly dried. It is evident that there is considerable waste of fuel under the present system of firing, as, if the necessity for heating the floor and solid brickwork of the oven and the saggers be taken

into consideration, probably a hundred times more fuel is used than is absolutely necessary for firing the *ware alone*.

There is little doubt that even the best firemen waste a considerable amount of fuel by the excessive admission of air to the oven, and analyses of the products issuing from the stack prove that as much as cent per cent too much air is often admitted, and with large 18 or 20 feet ovens this seems difficult to control. No doubt firing with gas or petroleum the consumption of air necessary can be gauged and admitted to a nicety; but these fuels at present seem only suitable for the smaller-sized ovens; at any rate, the problem of scientifically firing large ovens economically has yet to be solved.

While fully insisting on the advantage, nay, necessity, of theoretical knowledge, it should at once be admitted that experience alone can teach a fireman to fire an oven and obtain regular results, as, however theoretically perfect a man may be in the knowledge of firing, and given all the scientific aids recommended by various experts, and their names and recommendations are legion, without long experience of the different difficulties which may and continually do arise in firing, his knowledge is little better than useless.

All tests and trials will only show the heat at the particular place where the trial is, and it is quite easy to run the brickwork down in one place while the trials are still "not up" in close proximity. The manner in which an oven works, the want of draught in one mouth, the excess of draught in another, calls his attention to a stopped flue or a moved bung. The effect of wind on different quarters, the class of ware in the oven, the state in which it went in, its position in the oven, the body of which it is formed, the purposes to which it is afterwards to be put, the coal he is using, &c., have

all to be taken into consideration. The condition of the flues—for flues that have been long in use become rough and rugged, and the draught is thus impeded—also has its effect on the working of the oven. A hot sun beating on the stack undoubtedly decreases the draught, and so night-firing will always be found the most regular. Drawing air is a defect that an oven may develop quite suddenly, owing to a crack slightly opening in the brickwork, which is especially likely to occur in the arches over the mouths. Drawing water or damp from the soil is rarer, and if the oven has a well-made cork, should not occur unless through the accidental bursting of a water-pipe or drain.

These are a few of the small matters which may from time to time affect the working of an oven. People who say that "with proper scientific education" a man can fire a large oven which he has never seen before, and give satisfactory results by attending to rules laid down, only show how very little experience in the working of ovens they have had, and their recommendations should be regarded with suspicion and examined with the greatest care before being brought into use.

No two ovens work alike. There is nothing extraordinary in this; the same thing occurs with machines and engines; two locomotive drivers on sister engines, if changed, will not get the same results out of each other's engines, because they are not acquainted with their peculiarities. So is it with ovens. Ovens built from the same plans vary in the treatment they require, and the best results will only be obtained by the man who has studied their idiosyncrasies. Accidents happen, bungs move, trials can neither be seen nor drawn; experience only can then guide the fireman. The colour of the interior of the oven, the appearance of the saggers and the bricks in the flues, will all be guides for him.

It is rare to fire an oven without noticing something unusual, and the successful man is he who notices these little things, and knows from past experience what is the right thing to do, and does it at once. As in so many other things an ounce of experience is worth pounds of theory, though the ideal should be the two combined. The mere getting to a certain fixed heat at the places where the trials are is but the A B C of firing, which those who put their faith on trials alone would soon find out to their cost.

Firing is, undoubtedly, the most important operation in the manufacture, and it cannot be *too much* insisted upon that it is absolutely essential that managers who wish to really "manage" their works should have a *practical* knowledge of firing; as without this knowledge they are really in the hands of the fireman instead of controlling him. There is nothing occult or even difficult in firing, but it does require attention, practice, and observation.

CHAPTER XVII.

DRAWING BISCUIT OVENS AND BISCUIT WAREHOUSE.

WHEN the oven is sufficiently cool, the mouths should be punched, all the clinkers cleared out, and the ashes and rubbish carried away; the clamins should be pulled down, and the bricks piled up under one of the benches, ready for use in the next oven. Great care, however, is necessary not to pull down the clamins too soon, and two days' cooling should always be allowed—otherwise large pieces, and especially dishes, run the risk of being "dunted", the destruction of saggers will also be necessarily great, while the flues and brickwork will also suffer. Besides, if an oven be drawn too hot, the saggers cannot be handled with comfort, and the breakage on this account will also be large.

The floor round the oven should be sprinkled with water and swept up quite clean ready for "drawing", which is the term used for the removal of the saggers from the oven and the taking of the ware out of the saggers. It is, of course, desirable to accomplish this with as small amount of breakage as possible. Breakage more or less there always will be, and the object is to reduce it to a minimum; and any that does occur should always arise from accident and not from systematic carelessness or want of order. In some places it is the custom to make a sort of bench in front of the clamins, and each sagger as it comes from the oven is at once emptied, but the more general custom is to carry out a considerable number of saggers and place them one on the other outside the oven before they are emptied. To do this quickly a line is formed by the men, and

the saggers are passed from one to the other, and to facilitate the handing of the saggers in this manner the men should face alternate ways, as they thus receive the saggers in order without having to turn round.' This method is undoubtedly the quickest, as more men can work in emptying the ware from the saggers.

There should be a sufficient number of covering boards to put on the tops of the lower tiers of saggers inside the ovens, so that the men climbing up to remove the upper saggers from the bungs have a good firm footing to stand on. If there are not sufficient boards supplied to them they will stand on the sides of the saggers, which is sure to result in considerable breakage of both saggers and ware. As the saggers are passed out they should be put down carefully and levelly by the last man in the line, without jerking or knocking one heavily against the other, as it is in this part of the operation more than in any other that breakage occurs. A strong man should be chosen for this office, as it is as often as not from want of strength that saggers are put down roughly.

The men taking the saggers off the bungs inside the ovens will have to come out from time to time if the oven is still very warm, changing places with some of the men in the chain. If the oven is very hot the men will require pieces of flannels with holes in for the thumbs, to protect their hands, or thick gloves, to enable them to hold the saggers with comfort. When sufficient saggers have been carried out the ware is removed from them and carried into the biscuit warehouse, and for this purpose there should always be sufficient baskets, trays, or boxes, and it is far better to have extra baskets than to allow them to be piled up with ware, as pieces may fall out, and the weight is also likely to break the pieces at the bottom of the basket. When the ware

has been removed from the saggers, it should at once be carried into the biscuit warehouse, and should not be left on the benches or on the floor of the oven-house. Care must be exercised in removing the ware from the saggers and placing it in the baskets. Numbers of cup handles and other delicate salient pieces are knocked off if this is not attended to, and fragile articles, such as centre-pieces, &c., should be carried in by hand at once to the warehouse on being removed from the saggers.

As the saggers are emptied some of the men should be told off to carry them away and pile them up carefully in the place appointed for the purpose, the different sizes being all arranged together, so that when the next oven is placed, the men get at any sized sagger they require. If they are piled up mixed together several saggers may have to be removed to get at the one required, and those not wanted are put down anyhow and anywhere, which is a fruitful source of breakage. All ware whether cracked or broken, should be carried into the warehouse, and no one in the ovens should be allowed to throw away a single piece, and this is very important for several reasons:

(1) The payment for the work in the ovens is often made in accordance with the quantity coming out of the oven.

(2) It is necessary to know the percentage of loss in every oven.

(3) The cause of the breakage or loss must be studied to see where it has occurred, and to prevent it happening in the future.

(4) The warehouseman must know what pieces have been broken or have come out defective, so that if they are wanted for orders he can at once order them up again.

An oven should be drawn as quickly as is compatible with care, as the examination of the ware takes place afterwards in the biscuit warehouse. The warehouseman must keep an eye on his own people when emptying the baskets, &c, as much ware is often broken by them which is afterwards unfairly attributed to the placers when drawing the oven.

The Biscuit Warehouse should be fitted all round with strong penning or shelving, to store away any ware not immediately required. Heavy ware, such as plates, should be stowed below; the lighter hollow ware being packed away above. The warehouseman should go over his stock from time to time, so as to know exactly what he has, otherwise he may order up things which are already in stock, and it is never desirable to have old stock lying about, and as soon as one lot is sent out of the biscuit warehouse it is easy to order another lot forward.

As the baskets and trays of biscuit ware are brought from the oven into the warehouse, the warehouseman and his assistants, who are for the most part women, empty and arrange them on the floor merely according to size and shape. When the oven is all in the warehouse, they commence looking over cleaning and sorting the whole of it systematically, piece by piece. All the defective ware, from whatever cause, is put on one side, and when the oven has all been looked over the warehouseman classifies the defects. Those from bad firing in one place, those due to defects in making in another; those which appear to be spotted by iron or dirt in the body in another, and those for which he cannot account he should put on one side and specially call the attention of the manager to them. Then the workmen to whom the defects are due are sent for in turn, and the defects pointed out to them so that they may

avoid them in the future. This is absolutely essential if the percentage of breakage and defective work is to be kept low, and it is wonderful if these small matters are not attended to how quickly breakage and badly made ware increase.

It requires considerable experience always correctly to attribute defects to their true sources, though the majority of them are sufficiently apparent. For instance, ware that comes out brown or yellow is a fault of the placers; the saggers have not been properly wadded, and the flame has effected an entrance and flashed the ware. Ware that is dunted (cracked) is generally to be attributed to the firing. Dishes are especially liable to this defect. If the crack at the edge shows an opening, that indicates a "getting up" dunt caused by too rapid firing at the commencement, though it might also be a defect in making, or carelessness in placing, and if the dish be broken the surface of the fracture along the crack will be found to be rough. If the dunt shows no opening at the commencement of the crack, it indicates a "cooling" dunt caused by letting in too much cold air, either during the firing or after the fires have gone out, the latter being the most general cause. If broken, the surface of the fracture of the crack will be found quite smooth.

Ware broken in the clay state has a rougher edge than ware broken after it has been fired; then it is quite sharp. In either case these defects would probably be rightly attributed to the placers as they would be caused by want of care in placing or in drawing. It is no doubt difficult sometimes to decide whether a breakage or crack is due to bad workmanship, careless placing, or firing; but by noting how other pieces of the shape or class have come out of the same oven, it is generally possible to be pretty certain who is

responsible, though each man will naturally try and shift the blame on to someone else's shoulders.

The same remarks apply to crooked pieces. The maker is generally responsible for these, unless it is evident that they have been squeezed out of shape or put in a wrong part of the oven by the placers, or unless the oven has been palpably over-fired and the ware thus warped; but practice soon appreciates these differences, and a knowledge of where defects are likely to occur is a very great help. Spots of iron may be caused by men filing at their benches or by the magnets not properly cleansing the body, or through defective bearings of machinery, and the attention of the manager should at once be called to this or to any other apparent defect in the body. One rule must, however, be strictly observed, and that is no defective piece must be passed without attention being called to it. Broken ware should not amount to more than 4 per cent, the percentage of seconds will depend upon the "selection" required. The warehouseman must also give his special attention to any new pieces or new shapes coming from the oven for the first time, so that any alteration required in their manufacture may at once be pointed out.

All ware should be carefully cleaned and brushed with a stiff brush, to remove sand or dust, and sand-papered if necessary. White ware should receive extra attention, especially that which is afterwards to be decorated over glaze, and for which a special selection is required, as it goes directly to the dipper and does not pass through anyone else's hands; and nothing spoils the appearance of ware more than sand or dust under the glaze. It is of very great importance that biscuit ware should be well fired and regular, as, if irregular, when printed it will come out in different tones, and the ware is most difficult to dip satisfactorily, as it requires different strengths of glaze.

avoid them in the future. This is absolutely essential if the percentage of breakage and defective work is to be kept low, and it is wonderful if these small matters are not attended to how quickly breakage and badly made ware increase.

It requires considerable experience always correctly to attribute defects to their true sources, though the majority of them are sufficiently apparent. For instance, ware that comes out brown or yellow is a fault of the placers; the saggers have not been properly wadded, and the flame has effected an entrance and flashed the ware. Ware that is dunted (cracked) is generally to be attributed to the firing. Dishes are especially liable to this defect. If the crack at the edge shows an opening, that indicates a "getting up" dunt caused by too rapid firing at the commencement, though it might also be a defect in making, or carelessness in placing, and if the dish be broken the surface of the fracture along the crack will be found to be rough. If the dunt shows no opening at the commencement of the crack, it indicates a "cooling" dunt caused by letting in too much cold air, either during the firing or after the fires have gone out, the latter being the most general cause. If broken, the surface of the fracture of the crack will be found quite smooth.

Ware broken in the clay state has a rougher edge than ware broken after it has been fired; then it is quite sharp. In either case these defects would probably be rightly attributed to the placers as they would be caused by want of care in placing or in drawing. It is no doubt difficult sometimes to decide whether a breakage or crack is due to bad workmanship, careless placing, or firing; but by noting how other pieces of the shape or class have come out of the same oven, it is generally possible to be pretty certain who is

in such a way that the defect will be completely hidden.

White ware is often stamped or marked in biscuit with the manufacturer's mark, etc., by a rubber die first pressed on a flannel pad moistened with the necessary colour, or one of the printers may print off sheets of marks which the girls press on the ware and then pull away the paper again; this latter method is, however, more expensive although more satisfactory; but as the glaze will not be properly absorbed where the colour is, owing to the oil contained in it, the print after the removal of the paper should be dusted with a little plaster, or the printing paper may be washed off with plaster water, which would have the same effect. A printed mark has always a cleaner and better appearance than if merely stamped. The warehouseman must make special selection for his printed orders according to the different colours, and for filled in ware, matt blue or pink, he should always select rather easier fired ware than for the other colours. Very hard ware should never be sent on for printing if it can be avoided.

All pieces with covers should be carefully fitted before being sent on, or if for stock should be put away in the penning, each with its proper cover—otherwise it may happen that bodies and covers are printed up which do not fit, which is a cause of great annoyance and inconvenience when they come through in the glost warehouse. If by chance pieces come through the biscuit ovens with covers or parts that do not fit, the warehouseman should at once order up sufficient covers, bodies, or parts, as the case may be, specially to fit those pieces, so as not to have parts of ware lying about in the warehouse uselessly. He should always keep a few pieces in stock of the most current articles, so that in case of any sudden demand he is able to send on a piece or two to be printed or painted

which may enable some urgent order to be dispatched without loss of time.

The biscuit warehouse requires the greatest attention, as this is the point of departure for the arrangement of the execution of the majority of orders. All the orders which cannot be executed from the stock in the glost warehouse come to the biscuit warehouseman, for either white ware or printed or under-glazed painted, and if he has not the necessary pieces in stock he must order them up from the clay end. In ordering up he will have to slightly augment the quantity ordered to cover losses from breakages, &c. The quantity necessary will vary with different pieces, but he will soon be able to tell from the way the ovens come out the percentage necessary to complete his orders. Flat will generally require a larger percentage than hollow ware. The orders should be most carefully entered up in his book and checked independently, and he should mark off every order as it is executed, with the date of execution, as a reference.

It is very necessary that all sets should be sent on complete, and if the biscuit warehouseman has not the necessary pieces in stock to complete the order, it is far better to let the ware remain in biscuit till the necessary pieces have come through the biscuit oven and can be sent on complete, rather than to send part on and afterwards the rest when it comes through. It is quite useless to send *part* of the ware to be printed or decorated, and if this is allowed parts of orders will continually be coming through to the glost warehouse, on which all the expenses of decorating, glazing, and firing have been incurred, which cannot be packed owing to the absence of some of the pieces; the order remains lying about, and perhaps when the necessary pieces do come through, one of the pieces in the first lot will be found to be broken or chipped, and the packing has to be again delayed.

Apart from this, it is always as well to get sets of anything through in the same oven, as if parts are fired in different ovens they are more likely to vary in tone of colour should they by accident get a slightly greater or lesser heat.

The chief point in getting up the orders in the biscuit is that they should be sent through in such a way that the different parts of them will go through their various processes and arrive in the glost warehouse as near as may be at the same time, and so can be at once packed and sent off the works. If orders come through piecemeal and incomplete, it shows want of system and organization, most probably in the biscuit warehouse, and should at once be looked into, the cause ascertained and the defect corrected.

CHAPTER XVIII.

DIPPING: OR THE APPLICATION OF THE GLAZE.

THE most common methods of the application of the Glaze are the following:—

(1) By *dusting* the pieces with a dry powder of the glazing material, such as litharge or minium. It is usually applied to pieces in the clay state and when still rather damp, and is thus used for only the commonest sort of earthenware, in fact, when the biscuit and glost firing are combined in one process. It is very injurious to the workmen, as it is almost impossible for them to avoid breathing the dust of the poisonous materials floating in the air.

(2) By *sprinkling* the pieces with glaze of the consistency of cream; this method is employed for ware which, in its first firing, has become so vitreous that it has lost its absorbent power and so cannot suck up the glaze. The glaze is therefore allowed to flow over the piece while it is moved about from side to side till completely covered, when any superfluous glaze is removed from the piece by slightly jerking it. This system is also used with coloured glazes when the inside of a piece is to be glazed a different colour from that of the outside, the outside being dipped by immersion and the glaze being introduced into the interior with a ladle.

(3) By *volatilization*. This is carried out by bringing the biscuit ware to a certain degree of heat and then introducing the glazing material into the oven by specially arranged apertures in the crown of the oven and by the mouths, as in the case of salt glazing. The salt volatilizes, combining with the silica of the body, and

thus forms a coating of glaze on the piece, the saggers not being wadded, in order to freely admit the gases to the interior. In another application of the same process the saggers are washed with the glaze, and cups containing the powdered glaze are placed in the saggers, and when the necessary heat is attained the glaze volatilizes and the pieces of ware in the saggers are struck by the gases and become glazed. This process is usually described as "smearing", and the advantage of it is that the deepest and finest incisions and cavities are glazed without filling them or in any way spoiling their sharpness of outline.

(4) By *immersion*. This is the usual method of glazing fine earthenware, and as the quantity of pieces to be glazed is very large, it is the quickest and the most economical. The employment of this method is based on the characteristic of biscuit ware to absorb liquids. When the glaze materials have been sufficiently finely ground, as described in the Chapter on Glazes, they are mixed with the quantity of water considered necessary for the proper coating of the pieces when immersed in them. This proportion must be settled by experiment, and once the glaze is considered of a satisfactory consistency, a pint of it should be weighed, so that from time to time the weight of the glaze can be checked.

Trials should be sent through the ovens of pieces dipped at different strengths, that is to say, at different weights per pint of glaze, and by this means the most suitable weight of glaze is soon arrived at, and it can always be kept at the same strength afterwards. It is necessary to do this as dippers vary in the time they keep pieces in the tube, and so sometimes require slightly different strengths. As by the absorption of the water into the pieces, the glaze is constantly getting heavier and therefore thicker as every piece is dipped, the dipper

must from time to time add a sufficient quantity of water to compensate for this and to bring the glaze back to its original density.

In some places a glaze gauge is used formed of a graduated glass tube, terminated by two unequal bulbs. The smaller of these bulbs is filled with small shot, the neck between the two bulbs being carefully closed with a piece of cotton wool. The gauge is put in the glaze and sinks lower in it as the density decreases, the scale on the tube being read to make the necessary comparison. It is a very simple, and, at the same time, most accurate method of testing the strength of glaze. Ware, however, often varies, owing to difference in firing, in the strength of glaze it requires, so that gauged or weighed glaze must be only looked upon as a guide and not as a hard and fast rule. The majority of dippers can tell by long practice the thickness of the glaze by merely putting one of their hands in it. The heat of the hand slightly evaporating the water, the coating of glaze remaining on the hand shows the dipper the state of the glaze in his tub. When a piece has been dipped, the dipper can tell by scratching it with his nail if it has a sufficient body of glaze on it or not.

A piece of ware plunged into the liquid glaze at once absorbs the water, and acting like a filter allows the water to enter, but leaves the material originally held in suspension, evenly on the surface. The rapidity with which the operation can be effected also conduces to an equal layer of glaze being deposited all over the piece if all the different parts of the piece are immersed for the same duration of time, and so the part of the piece first entering the glaze should also be the first to leave it. The piece should therefore be passed at the same pace through the glaze, care being taken that it is also withdrawn at the same pace as it enters. If this is not

attended to the piece will have more glaze on one side of it than on the other.

Time is a very important factor in the operation, for if the immersion is too rapid the piece will not have had time to sufficiently absorb the water and to leave a coating of the proper thickness of glaze on the surface; on the contrary, if it is too slow, the glaze coating may be too thick, or the water may begin to dilute the glaze on the piece again, thus leaving the coating uneven. In a given time the thickness of the coating will be in proportion to the thickness of the piece, that is to say, a thin piece would absorb less water than a thick one, and so the coating of glaze would be thinner in the same time.

Therefore, very thin ware should be dipped in rather thicker glaze than that used for ordinary purposes. As a general rule there is not much variation observed in the thickness of coating on the same piece, unless some of its parts are very thin indeed, but the edges of pieces will be generally found to be less thickly coated than the centres, and care must always be exercised to avoid extra thick glaze remaining in any hollows. The difference between the firing of pieces makes a vast difference in the way they absorb glaze, and it is generally best to have the dipping trough, which has largely taken the place of tubs, divided into two parts; the ordinary glaze being on one side for the well and evenly fired ware, and slightly thicker glaze on the other side for any harder pieces which do not, of course, absorb so quickly. Easily fired ware which absorbs quickly should either be dipped in specially prepared glaze, or, if there are only a few pieces of it, it may be dipped first in water, and then in the ordinary glaze; by this means, having already absorbed a considerable quantity of water, it will not take so thick a coating of glaze when dipped.

The dipper should from time to time stir up his glaze to prevent the heavy material sinking to the bottom, as this is the richest and best part of the glaze. He should also pass the glaze two or three times a day through a fine lawn to take out any impurities that may have been brought into it by the ware that has been dipped.

In dipping hollow ware care must be taken that the glaze is emptied quickly from the inside and not allowed to coat one side more than another, nor remain in the bottoms, and any piece that has an extra thick coating of glaze, no matter how hard the glost fire may be, is always liable to the defect of crazing, that bugbear of the manufacturer. Too thick glaze will also spoil the appearance of decorated ware by making the colours run. In dipping hollow ware the dipper should move his fingers and not keep them still, pressing on the ware at the same point, or where his fingers touch the piece it will not be glazed. He must also shake the pieces well, so that no drops or tears are left on the edges, as the more ware has to be touched up or cleaned after passing through his hands, the less even will be its appearance; ware that has not to go through the repasser's hands at all always looks the best.

Hollow ware should be dipped in rather thinner glaze than the flat, which is now usually dipped with a hook. For this process the dipper has a sort of strong leather thumb stall, fitting tightly to the thumb, to which is attached a short piece of iron or steel wire, at the end of which is a hook shaped to fit the edge of a plate. He hooks the hook over the edge of the plate, the plate being face upwards, the fingers of the hand supporting the plate on the opposite side to the hook. The plate is rapidly passed through the glaze and, with a violent jerking swing of the elbow and wrist, the superfluous glaze is thrown off the edges, leaving the plate perfectly

glazed without tears or drops on it, and ready to go straight into the oven without being touched by the repassers. The dipper must be careful to keep the fingers of his hand quite straight, as, should they bend, they will touch the under side of the plate, which, in consequence, will not be properly glazed. This is by far the quickest way of dipping, a good man getting through a lot of work, and the result is also superior to that obtained by other methods.

Good dipping is very important, and it requires long experience to dip every class of piece with equal success; therefore, it is better to keep some dippers only dipping flat, while others confine their attention to hollow ware, as the difference in the thickness of the glaze required by the two different classes is quite sufficient to upset the balance of a man if changed from one to the other.

Troughs or tubs should be kept specially for white ware, while others are used for printed and decorated. If the same tubs are used for both, the white ware is sure to suffer sooner or later from the colour of the printed ware. After the ware has been glazed it is looked over by the repassers, who clean any drops of superfluous glaze with a very fine thin steel knife or a piece of flannel, and with a broad brush apply glaze to any part which has not received the necessary amount.

In printed ware the outline of the pattern should just be visible through the glaze, but it should not be so thin as to show the colour; for this reason, when the ware has been looked over, it is placed on boards in the dipping drying room, and each board is marked with the colour with which the pieces on it are decorated, by putting a broken bit of ware of the same colour on the end of the board; this is to enable the oven men to discriminate between the different colours when they come for the ware to place in the glost oven. Each colour has

its proper position in the oven, and if put in another part it would very probably come out unsatisfactorily.

In some factories the dipped ware is placed on a moving platform, or endless band, which passes continually through a highly heated chamber, and it is received at the other end as it issues from the chamber dry and ready for the oven. In any case it must be arranged on boards in a shop where the men can see it, in order to make their selection for the different parts of the oven. Should it be desired to glaze a piece in certain parts leaving the other parts in biscuit, and it is difficult to do this without immersing the piece, the part to be left free from glaze may be painted over with wax, or oil, or any other greasy substance which will prevent the glaze from being absorbed. The piece is then dipped, and when fired the part that has been oiled will remain biscuit, while the surrounding parts are all glazed.

Dippers require stillaging in the shop on which boards can be placed for ware, both before and after dipping, and a drying stove. The tubs should be from 3 to 4 ft. across, though they have been largely superseded by troughs, as the latter are more convenient for the dipper to stand in front of, and he has not so far to reach when a piece has to be dipped in the thicker glaze. All tubs or troughs should be made of good hard wood, to prevent absorption, which causes the glaze to set at the bottom; they are also more durable than if made from soft wood, and do not splinter when the glaze is stirred with the paddle.

The dipper will require a board with wooden ribs on it and holes in it, or an iron grid made of thin hoop iron fixed over the edge of the trough or tub, to put the ware on as he dips it, from which it is removed by one of his assistants, of whom he has two or three, to the drying stove or to the repassers, as may be necessary. The

assistants fetch the ware, hand it to him, and remove it when dipped. Some dippers prefer boards with a lot of nails driven through them, on which the ware may be placed after dipping, but wet iron in whatever form should be avoided when possible. He will also require a wooden paddle to blunge up his glaze, a couple of lawns, which should always be in good order, and several pails, which under no circumstances should be used for any other purpose. His tubs or troughs should have covers with padlocks to them, and should be covered when not in use, which prevents any extraneous matter from getting into the glaze. He should be very careful that the glaze when given to him from the stock tubs has been thoroughly blunged up, and that none of the goodness has remained set hard at the bottom of the tubs, as this would naturally completely upset the composition of the glaze. He should then pass it through a fine lawn into his dipping tubs to make sure that it is clean, and should then add sufficient clean water to bring it down to the necessary liquid state.

Glaze in the lead-house is always kept in a thicker state than required for dipping, as it is an easy matter for the dipper to add water, but were it too thin the dipper would have to wait a considerable time till the material in the glaze had settled in the bottom of his tub before he would be able to take off the superabundant water. Apart from this, it is undesirable to take off water from glaze, as it always contains some of its constituent parts, and may thus upset the balance.

A dipper must be exceptionally clean in all his operations, and should always have a sponge handy to wipe up any splashes of glaze. His tubs and boards must be kept thoroughly clean, as also his shop, which should be as airy as possible. He and his assistants must be orderly in their habits, wearing aprons and overalls, and

always washing carefully after work, carefully cleaning their nails and any place where the glaze is likely to stick, and always changing their clothes after work. If cleanliness were strictly observed, and care were taken not to throw or spill glaze about, not only would it be of advantage to the manufacturer, but the general health of all employed in the dipping shop would be improved, and illness from the bad effects of glaze would be reduced considerably.

Women are largely employed in most of the departments of a pottery, but all things considered, the dipping shop is one into which they should not be admitted. It is needless to add that no meals should be taken in the dipping shops, under any circumstances. Should the dipper notice any ware improperly cleaned, on no account should he dip it; if white ware, he should send it back to the biscuit warehouseman, and if printed or painted, to those who are responsible for cleaning it. This is most necessary, as improperly cleaned pieces do not take the glaze well; and not only must the one dirty piece be taken into consideration, but part of the sand or dirt will come off into the glaze and thus be the cause of a whole batch of dirty ware. All the attendants should be careful always to have their hands clean and free from grease, or wherever they touch the pieces with their fingers they will not take the glaze properly.

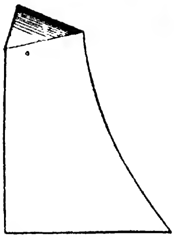
The best method of paying dippers is by count, that is, a price per dozen for all ware counted from the glost oven, less any pieces that are faulty through defective dipping. Sometimes the price also includes the placing and firing, but that is merely a matter of arrangement, but the principle should be adhered to, as it is then to the dippers' interest that the ovens should be well filled and that the placers should never be waiting for ware. Under this arrangement he would pay his own assistants and ware cleaners.

CHAPTER XIX.

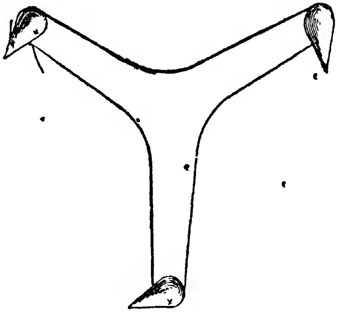
SPURS, THIMBLES, STILTS, ETC., AND THEIR MANUFACTURE.

ALL pieces of earthenware covered with a glaze, which, when submitted to heat, melts into a glass, during the firing must be isolated one from the other. They must not touch or they would adhere together, thus causing great loss. They cannot therefore be piled one on the other, as in the case of biscuit ware, nor can each piece be placed singly in the sagger, as the cost of firing is so great that only the more expensive pieces can be treated in this manner. Pieces are, therefore, placed on each other, or inside each other, but kept apart by various forms of supports or stilts contrived in such a manner that the ware resting on them, or on which they rest, shall be marked as little as possible. There will, however, always be some mark, as the point of contact prevents the glaze running quite evenly there.

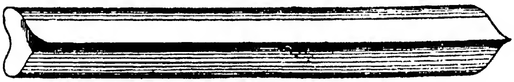
Great ingenuity has been expended in devising and manufacturing appliances for placing glost, as not only must the necessity of supporting the pieces be ever present, but economy in space in the saggers to get in as many pieces as possible must be studied. The manufacture of supports, &c., has become a trade by itself, and special machinery has been designed for their production in large quantities. It probably would not pay the potter, working on the ordinary scale, to make all the different shapes and sizes of the various stilts, spurs, saddles, thimbles, dumps, &c., that he requires for placing, as some of them are used in such small quantities that the expenses of the necessary dies and machinery would counterbalance the saving in cost of production ;



DUMPS.

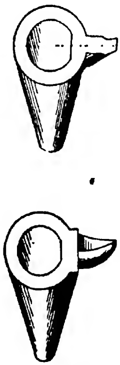


STILTS.



SADDLES.

COCKSPURS.



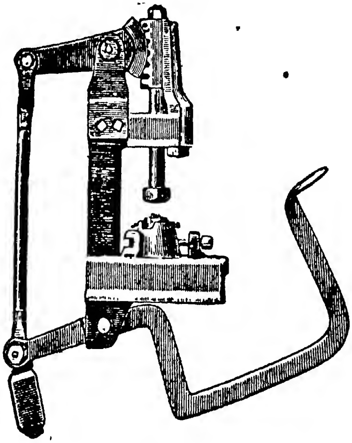
THIMBLES.

but it undoubtedly is a saving to make the ordinary shapes and sizes, of which considerable quantities are used.

From one cause or another, there is always a certain amount of dirty materials about the works—scraps that have fallen on the ground, clay from the slip-house floors, and from the washing of the cloths, sweeping from the clay stores and shops, which cannot be used in the ordinary manufacture—and all these materials which are often wasted are quite suitable for the manufacture of stilts. The body for stilts should be sufficiently refractory to support the pieces during the firing without bending or giving way, and letting down the pieces one on the other, and must be sufficiently plastic to "come up" well in the dies, that is to say, that all points and edges must be quite sharp and fine. This is, after strength, the most important point in the manufacture of supports, as if the points are blunt and the edges broad, the marks on the pieces will be large and unsightly. An ordinary body with some addition of ball clay will make a sufficiently good stilt body, and by this means all odds and ends are used up instead of lying uselessly about the works, and as they require a hard fire they can be put over the bags in the biscuit oven, a position it is often difficult to find suitable ware for.

The body may be made up in the slip-house, care being taken to afterwards wash and clean all arks and cloths used; or if not convenient, it may be made in tanks and left to dry; or it may be made on a slip-kiln; in fact, cleanliness of the body not being of very great importance it may be made up almost anywhere. The manufacturer, unless in a very large way of business, would find presses, making one piece at a time, sufficient for his purpose, as they will turn out quite sufficient quantity for his own consumption, and would probably use up all the dirty material that can be collected from time to time, and in

thus manufacturing on a small scale the wad-box will be found a most useful adjunct. We will now briefly allude to some of the supports in most general use.

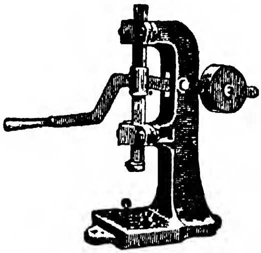


DIE PRESS.

Saddles are triangular strips, though sometimes slightly hollowed out at the sides, on which the edges of plates, saucers, and dishes rest when reared. They may be made from the wad-box by having a metal plate cut into a triangular form, care being taken that the points are filed quite sharp. As the clay is expressed the triangular strips are received on a board, and the attendant should smooth them with a moist sponge to ensure a fine edge, and cut them into requisite lengths.

Thimbles are little pieces shaped not unlike a thimble, as their name implies, with an arm of varying length and curve fixed to them and finished with a point. These are used for rearing plates, saucers, dishes, &c. The end

of each thimble fits into the next one to it, and the plates, &c., rest just touching the point on the arm. These also are made from dies in a press. The wad-box is, however, first brought into play, a metal plate being cut somewhat similar in form to the section of a thimble with the arm attached; the strip of clay passing through the plate is cut into equal bits after it comes out, by a cutter formed of a number of tightly strained equidistant wires attached to a handle moving on a hinge and working between uprights. These pieces of clay are then placed in the die, the handle of the press is pulled down as already described (page 165), and the thimble is formed. The die is in two parts, and the upper one, which forms the point on the arm, requires very accurate filing; the plunger that forms the interior of the thimble must also be so arranged that the thimbles fit tightly into each other and do not "rock"; to avoid this defect the side of the interior over the arm is usually flattened slightly. Should the clay not deliver easily, the dies can be lubricated with a little mineral oil.

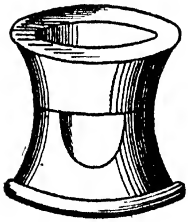


STILT PRESS.

Stilts of various sizes are made in exactly the same way. These are formed by three short arms joined together at a common centre and usually furnished with points. The necessity of having the points thoroughly sharp must be always kept in view, and it will be found that by making the points at rather a wider angle and not so elongated as they generally are, the clay has easier access and the points will "come up" better. Stilts are made in various forms, some with

points above, others with points both above and below; those are used for placing cups in bowls or bowls on each other, egg-cups in mugs, &c. Some are made without points, but with sharp salient ends such as cross stilts to fit against the interior of conical cups, another cup standing on the stilt half-way down in the cup and thus saving space. All these stilts can be made by first roughly squeezing the clay from the wad-box in shapes that can be afterwards cut into pieces suitable for the die presses.

Cockspurs can also be made from dies. They are small triangular pieces, having one point above in the centre and three small points below, one at each angle of the triangle. They are used for placing common plates and dishes and other ware, and they are made in various sizes suited to their different uses. The disadvantage of them is that they make three marks close together on a piece, and they have fallen largely into disuse for plates and dishes since the introduction of thimbles. Many other kinds of supports are necessary, and the manufacturer will often have to design forms to suit his special needs.


NATCHES.

Natches for moulds may also be made in the same manner, but when fired they should be fired together, "hump and hollow," so that they fit absolutely accurately, and they should be kept in stock together, to avoid the trouble of fitting them up again afterwards.

In making some pieces with dies it will be found necessary to have minute holes bored in different parts of the dies to enable the air to escape, otherwise difficulty will be encountered in getting up the points. All forms

of stilts should be fired in the hardest part of the biscuit oven, and the more fire they get the better; they should never be fired in a glost oven, as they may not get sufficient heat, and should they afterwards get a harder fire when used in placing they will collapse with the ware; even if they get the same fire they have had before, the softening influence of the glaze would cause them to bend, and the result would be much loss from stuck ware. Good stocks of all stilts, saddles, &c., should always be kept, as it is most detrimental to good placing if supports of one particular sort have all been used and another unsuited to the purpose is substituted. They should always be kept in a dry place, as if allowed to get damp they will fly to pieces, letting down the ware in the oven. Whenever they are used a second time the points or edges should be dipped in bone slip. A very thin wash will be sufficient to prevent the ware sticking to them. This, however, applies more to saddles than to any other form of support.

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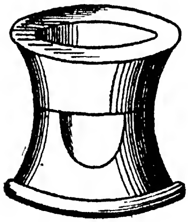


NATCHES.

Natches for moulds may also be made in the same manner, but when fired they should be fired together, "hump and hollow," so that they fit absolutely accurately, and they should be kept in stock together, to avoid the trouble of fitting them up again afterwards.

In making some pieces with dies it will be found necessary to have minute holes bored in different parts of the dies to enable the air to escape, otherwise difficulty will be encountered in getting up the points. All forms

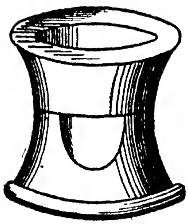
exterior should also be painted round with calcined bone slip, so that after the firing they will not stick together, and can be easily removed from the bungs; should this be neglected, the saggers will stick together by the volatisation of the glaze, and there will be great breakage, both in saggers and ware, in removing them from the oven. The centre of the bottom of each sagger outside must be also washed with glaze, as it forms the cover of the sagger next below it, and were this not attended to the upper parts of the pieces would probably be short glazed, the more absorbent sagger sucking the glaze from the pieces of ware. The outer edges of the sagger, which rest on the edges of the next sagger below it in the oven, should be washed about 3 in. wide with bone or flint; the latter, however, is not so satisfactory, as it is liable to chip off during the firing, and adhere to the melting glaze on the ware. A mixture of the two materials is sometimes used.

When the sagger has been properly prepared, the placer takes it to his bench and sprinkles the bottom of it with "bit stone"; this is either calcined flint chips or quartz ground to about the size of wheat. It is necessary that it should already have been fired, as during the first fire it flies and jumps about owing to the moisture in it, and it would therefore, if used unfired, stick to the glaze and spoil the pieces. The object of it is simply to make a rough bottom to the sagger, as, were the bottom smooth and covered with glaze, the pieces placed in the bottom would stick to it.

It takes considerably longer for a glost placer to become proficient in his work than for a biscuit placer. He has to study carefully the saving of space in the saggers so as to get in as many pieces as possible in such a manner that they will not touch each other nor the sides of the sagger, and at the same time to make a

points above, others with points both above and below; these are used for placing cups in bowls or bowls on each other, egg-cups in mugs, &c. Some are made without points, but with sharp salient ends such as cross stilts to fit against the interior of conical cups, another cup standing on the stilt half-way down in the cup and thus saving space. All these stilts can be made by first roughly squeezing the clay from the wad-box in shapes that can be afterwards cut into pieces suitable for the die presses.

Cockspurs can also be made from dies. They are small triangular pieces, having one point above in the centre and three small points below, one at each angle of the triangle. They are used for placing common plates and dishes and other ware, and they are made in various sizes suited to their different uses. The disadvantage of them is that they make three marks close together on a piece, and they have fallen largely into disuse for plates and dishes since the introduction of thimbles. Many other kinds of supports are necessary, and the manufacturer will often have to design forms to suit his special needs.



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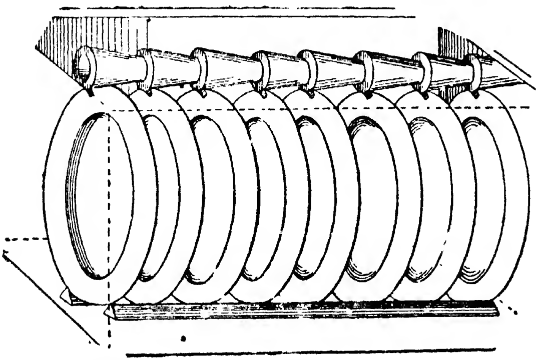
In making some pieces with dies it will be found necessary to have minute holes bored in different parts of the dies to enable the air to escape, otherwise difficulty will be encountered in getting up the points. All forms

the others, and another plate is put on them, and so on till they are almost level with the top of the sagger. A cover is then fitted on the three top thimbles, which keeps them steady, and the top plate free from dirt. By this means there are no marks either on the face or edge of the plate, but only three small marks on the rim at the back.

(2) The general current ware of this class is reared by thimbling or running. To carry out this method properly,



PLATES REARED WITH THIMBLES AND SADDLES.

the bottom of the sagger should be level, so that the saddles lie flat along the bottom; should it not be, the saddles are fixed in bits of clay so that they will not move. The sagger should be of the ordinary oval shape and slightly higher than the plates themselves, so as to leave room for the thimbles above them. Two saddles are then fixed across the sagger lengthways, just sufficiently wide apart to prevent the edge of the plate touching the bottom of the sagger when reared across them.

The placer should reject any saddles that are not quite sharp, or the glaze on the edges of the plates will stick to them, and when removed from the saggers pieces will be broken out of the edges, causing what is known as "plucked" ware. A thimble is then fixed to the side of the sagger at the top with a piece of wad clay, at such a height that the back of the plate will just rest against the point of the arm, care being taken that the edges of the first plate do not touch the sides of the sagger, and that the thimble is not above the level of the top. Then thimbles are fixed one in the other right across the sagger, a plate being reared against each, and the last thimble is fixed to the opposite side of the sagger with a piece of wad clay. There will also be room for two or three plates at the side reared on short pieces of saddle, and the clay fixing the first thimble to the side will be sufficient to hold up the two or three thimbles necessary.

The plates must be nearly upright, that is to say, almost on the balance, so that they only just lean back against the arm of the thimble, and really have the appearance of leaning forward on account of the weight behind in the ball of the plate; and this is much more emphasised in the case of soup plates, whose weight is much greater behind. About 22 8-inch plates can be put into an ordinary-sized plate sagger. It takes a little time to learn to thimble plates well, but dishes, and especially the larger sizes, are more difficult still, and it is best to select one man specially for this work, and then, should they come out badly, there is no doubt as to who is in fault. Thimbles after being fired should be looked over, as many can be used again, but any that have not sharp points and are at all doubtful should be thrown aside, as it is very false economy to spoil a plate for the sake of using a thimble a second time.

In "running" plates much the same process is gone

through, but a cockspur is used instead of a thimble, and the plates are not so much balanced, but rest on each other. This process leaves three small marks on the back of each plate and one on the front, besides the marks of the saddles on the edges, whereas by thimbling them there is only one small mark on the back and the two saddle marks on the edge, but if the saddles and thimbles are well made and the ware is properly placed, after it has been sorted the marks will hardly be detected.

(3) The very commonest plates, seconds, &c., are spurred up. Three spurs are placed in the form of a triangle on the border of the plate, and the next plate rests on them, and so on. The plates are usually placed face downwards, and great care must be taken that the spurs come exactly on the spot, on the plate, that rests on the spur below, otherwise they are almost sure to go crooked. Great loss arises in bad or careless placing of plates in glost, and when loss occurs it should at once be carefully looked into to arrive at the true cause.

It may be taken as a general rule that best ware, when the price will afford it, should be placed alone—always, of course, excepting flat. The placing of hollow ware requires considerable study, as it is often false economy to pile too many pieces on each other, as the lower ones may collapse with the weight, and so, if demand is pretty regular for certain articles, it is as well to make a list of how the articles can be best combined. Even more than in biscuit is it necessary to have a varied selection of heights in saggers, and, for exceptional shapes that require unusual methods of placing, special saggers must be made with ledges or projections in different places, off which they can be placed or slung. In fact, glost placing is an art, and for artistic work and figures each piece requires to be separately studied if loss is to be avoided. Low saggers are often very useful,

as, if there is no ware which can be combined with cups, they, or similar low ware, can be placed in the saggers by themselves.

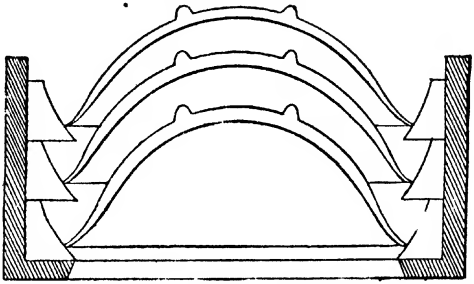
The placer should always clean off the glaze from the bottom of hollow ware by rubbing two pieces one against the other, or against his apron ; thus the bottom of the pieces will hardly be glazed, but merely smeared, and they will not stick to the bottom of the saggers ; this is especially necessary with pieces that have at all delicate feet, as they will stick to the bottom of the sagger, and very probably in removing them they will be broken off. If pieces are made in sets of sizes, it is generally better, in placing them inside each other, to skip a size, as often two following sizes are likely to get stuck together if there is the slightest movement in the bung, and, however carefully bungs may be arranged, there is almost always some slight movement.

Hollow ware, such as soup-tureens and salads, may either be placed on their feet with a light piece inside them on a stilt if slight marks are not objected to, or else a mug or similar piece may be placed with a stilt on it, and the soup-tureen or salad can be placed upside down over it, being slung or supported by the stilt. The latter is probably the better way, as it avoids all chance of dirt falling inside them, and the inside of these pieces is always a very noticeable part.

It is always desirable to fire covers of decorated pieces in the same saggers as their bodies ; they are thus sure to get the same fire, and should come out of the same tone of colour. Best basins must be fired by themselves, as they must not be marked inside, but should their shape permit of it, they can be fired on props in "ringers", as described under sagger-making, and by this method more can be fired in the same space. They may also be placed off dumps, upside down, which is a good precaution

against dirt, but the saggers should then be exactly adapted to their size.

Second quality basins may be placed off three large thimbles, one over the other, upside down, which will leave three small marks on their edges, and the commonest sort may be placed also upside down, but slung off each other on stilts, which will, of course, leave marks in the centre. Chambers must be stuffed, whenever possible, with bowls and cups or any suitable ware, and should never be placed alone unless they are special pieces



BASINS PLACED IN A "RINGER" SAGGER WITH "DUMPS".

for highly decorated sets. Cups may be jacked on each other, that is, edge to edge, and if the glaze is first carefully rubbed off the edges, the marks will be very small, though, perhaps, too apparent for the very best ware, which must be placed alone or on cross stilts fitted into the cup about half-way down, if the shape permits of it; by this method two cups go in the space of about one and a half.

If the price would permit of it, it would be far more satisfactory to place every piece by itself, but, unfortunately, it will not, and every means of placing ware and every combination must be studied to reduce the cost

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particularly observant and careful in bringing the ware from the dipping drying room not to mix the colours, as should the delicate colours be put in the wrong part of the oven the result will be disastrous. In carrying the saggers into the oven they must be kept perfectly level, so that the pieces may not fall off the various supports, and they must be most carefully placed on the bungs without any jerk or roughness, or grains and dust will be knocked off the sagger, and, falling on the ware in the sagger below, it will disfigure it. For this reason covers are often made to fit in the saggers, and supported by pins to protect any specially expensive pieces from dirt. The bottom of each sagger when lifted from the placing bench should be wiped to clean off any dust or dirt that might fall on the ware when the sagger is placed on the bung.

It is the more general custom for each placer to carry his sagger into the oven, and place it on the bung, but in some factories one man is appointed to place each sagger on the bungs as the men carry them in to him, and this method, if properly carried out considerably diminishes losses; for the man who is always arranging the saggers on the bung notices that the wad clay is properly placed on each sagger, and can also see that all pieces are properly arranged inside, and that none of the ware has fallen off the supports in carrying it in the oven, and that the plates have not fallen forward against the thimbles, which would mark them in front, and he can study the best way of building up each bung.

It is evident considerable care is required with saggers full of glost ware on account of their weight—a sagger full of plates will weigh some 75 lb. Wadding and proper filling up of cracks is very necessary in glost, as, if a sagger is not properly stopped and flame and sulphur gets in, the glaze will be quite dull. A glost placer

should place about six bungs a day, but the number will depend on the class of ware and the distance he has to fetch it from the drying stove.

Whenever the ware will allow of it it is a good plan to box the two top saggers (for ewers or other high pieces), as it saves covering the top sagger and at the same time makes a level bed for the green saggers. The trials are placed in the first ring opposite the trial holes, exactly as in biscuit, and when the placing is finished the clamins are built up in the same way. Any ware left over should be carried back to the drying room, stilts, &c., should be taken back to their proper place, and the benches should all be tidied up before the firing is commenced.

Ovens are very generally left untidy, but there is no reason for it, and everything should be kept in its proper place and in order in the oven-house, as in every other part of the works. Rubbish should not be allowed to collect under the benches, and any coal left over from a previous firing should be neatly heaped up in places where it will interfere neither with the drawing nor with the placing, as the case may be. Ladders, barrows, punching pokers, drawing rods, coal hammers, &c., should have their appointed places, and should always be kept there when not in use, otherwise at night in the dark it is very easy to trip over some instrument left where it should not be, and a severe fall may be the result. Let each man be held responsible for his tools, and he will then take care that they are at hand when wanted, and not left about for any one to make use of. It is often difficult enough in the day-time to find some article that is wanted on an emergency and has been mislaid, but at night it is ten times worse.

CHAPTER XXI.

GLOST FIRING.

The fireman should examine his oven with equal care and in the same manner, after each firing, as recommended in the Chapter on Biscuit Firing, and during the placing he should see that his trials are put in the proper position; they should be in the first ring, and on a piece of glazed shard; and arranged so that they can easily be drawn out, and if possible the trial bung should be so placed that the saggers in the second ring can be seen. It is as well to have a piece of lighted candle put in each trial sagger in turn, and he can then go round outside the oven to each trial hole and thus make sure that the trial saggers are at the right height, and that his trials are arranged as he likes them

When the placing is finished the clamins are built up, but they should not be luted till an hour or so after the oven has been lighted, and the mouths are lumped, but with rather more coal than would be used in the case of a biscuit oven, and the fires are lighted in the manner already described. The object of the glost firing is to melt the glaze so that it shall run equally over the pieces of ware, and as the ware only contains a small amount of moisture, that is to say, the water which the piece has absorbed when dipped in the glaze, and which has not been completely evaporated in the dipping drying stove, the heat may be got up as soon as possible without fear of the ware cracking from this cause, in fact, "getting up" dunts can hardly occur with ware that has already been fired to a heat sufficient to drive out all the moisture

originally held in suspension in the clay. Though, as the wad clay between the saggers is moist, time must be given it to dry, as, if it is heated too quickly, it is likely to fly off, sticking to the ware in the saggers and admitting the flame into the saggers, causing considerable loss in either case. If, however, there is a considerable quantity of green saggers in the oven it will be necessary to go a little carefully at first. The baitings will be put on at shorter intervals than in the case of biscuit, varying from one and a half to three hours, in accordance with the size and draught of the oven and the amount of coal used in the previous baiting, and as the firing continues the coal is put on at shorter intervals, and the same methods for regulating the influx of air are employed, and the firing conducted in much the same manner as would be the case during the last few hours of a biscuit oven.

Care must be taken that the heat is a continually increasing one, and that it is not checked or allowed to go back in one quarter, so that it has afterwards to be got up again; the only way to increase heat is to augment the quantity of fuel burnt, and unless great judgment is exercised in the putting on of extra coal it may have the opposite effect by decreasing the draught, as whatever coal, in excess of that which can be freely burnt off, is introduced into the mouths will only result in smoke and soot, which obstruct rather than accelerate the increase of heat. The fireman should see through the spy-holes that the colour of the heat does not decrease, and by constant practice his eye becomes trained to note the varying changes of colour in the brickwork, saggers, &c.

Once the necessary heat has been obtained no more coal should be put on and the firing should be stopped and air admitted to the oven, as, if the oven is held for some time

at the highest point of heat which is required for thoroughly melting the glaze, fire is evaporating and destroying some of the constituent parts of the glaze, and the pieces on being drawn will not have the brilliant velvety appearance they otherwise would acquire. There is nothing like a quick steady fire to "bring up" a glaze well, and the sooner the necessary point is reached the better, both on account of economy in coal and for obtaining brilliancy in the glaze; 16 to 24 hours is about the time usually required, but this will, of course, depend on the glaze, the ware, the fuel, and the oven. But the shorter the time, under similar circumstances, the better will, as a rule, be the result. For this reason coal is preferred that gives a long flame rather than one that produces great heat close round it, and burns with only a short flame which will not travel so readily to the centre, and it is therefore better to select coal for glost firing in large lumps, and as fresh from the pit as possible, as it thus contains all its gases and strength, and it will be found far more effective than the same coal from the same pit in smaller pieces.

It will be usually found to be very false economy to use slack or inferior coal in glost ovens because it is low in price, as it will almost always prove to be very dear in results; by using the best fuel there will be no occasion to punch out the clinkers, which is always a detrimental operation in glost firing. Wood, on account of its long flame, was used in many places on the continent for glost ovens, even after coal had been generally substituted for biscuit purposes; but as the heating power of coal to wood is as 15 to 8, it is evident that in most places coal is by far the more economical, and gives at least equally good results. Steady firing is absolutely essential, for should the firing be flashy the ware is likely to be blistered, especially if the fires are allowed to get low

just as the melting point of the glaze is reached, and are then started off suddenly again.

"Feathering" may also be caused by not keeping up the heat steadily, and by an over admission of air when the glaze is in a melting state. As soon as the oven shows colour a round of trials should be drawn from the top to see that all the quarters are equally forward, as it is far easier to regulate the heat at this period during the firing than later on. The tops will be quite sufficient to guide, as they are sure to be slightly ahead of the bottoms. The trials in most general use are the red clay rings already referred to, and as they are dipped in a softer glaze than the glaze on the ware, they are affected at a lower heat; they then go through all the gradations of colour from dark red to black, and thus show by comparison with each other, and with special sample trials that have been kept from the most successful ovens fired, the state of the heat in the different quarters of the oven. The comparison with each other at different times of the same firing will also show the amount of heat gained between the drawings of any one quarter.

Towards the end of the firing trials should be drawn at short intervals, as some ovens "come up" very suddenly, half-an-hour sometimes being sufficient, especially in large ovens, to raise the heat enormously. As in biscuit, trials are most useful guides in firing, but the colour heat of the flues and the appearance of the interior of the oven will always be the best indication to the experienced fireman. In drawing trials, moist clay mixed with sand should always be at hand to lute up the brick in the trial hole after the trial has been drawn; this should be done quickly and the brick put back as soon as possible, to avoid the rush of cold air into the oven.

Trials should never be drawn when the mouths have just been baited, but should be left till the coal has partially

burnt off. If the fireman leaves a good deal of the work to the sitters up, which he often has to do if he has ovens constantly firing, he expects them to keep the oven steadily going forward, and looks in now and then, or only comes an hour or two before the finish, which is, of course, the important time. Under these circumstances teil-tale watches or clocks can be used with the greatest advantage. He can then tell his men at what intervals, more or less, the oven is to be baited, and at each baiting the man in charge turns the knob or key in the watch which records the operation. This is a proof that the man has attended to his instructions and has not been asleep, as has often happened; and when the fireman has returned, expecting to find the oven ready for finishing, he finds, for some apparently unaccountable cause, that the oven is hours behindhand. Sitters-up have been known to let their fires completely out; with a tell-tale watch this could also occur, but the man's carelessness is at once detected and his services dispensed with for the future. A common excuse for short-fired, crazed ware in certain parts of the oven is that the oven is drawing air, as this is admitted to be a fertile source of crazing.

Drawing air is caused by bad brickwork, especially between the mouths, and if this defect exists the oven should be carefully pointed with fireclay in the mouths, and with mortar in the ordinary brickwork. In fact, it is always advisable to stop up any visible cracks in the oven with mortar or clay. "Drawing" may be caused by filling the mouths up to the arches with coal, thus stopping the draught, which may almost put out the fires in the back of the mouths, and thus allow the admission of cold air through the bars at the back directly into the flues. It should be noted that the bars in the mouths should always be pushed right back till they are in contact with the brickwork under the flues, as,

should there be any space left between the bars and the brickwork, cold air can draw into the flues, which would render firing almost an impossibility.

"Smoked" ware, which is really the reduction of the lead in the glaze, thus turning it black, is almost always attributed by the firemen to bad or dirty fuel, but it is really due to allowing clinkers to collect, and to inattention in properly regulating the influx of air and neglect to clean out the smoke and shoulder holes. It may to a certain extent be truly attributed to the fuel, in that some coals contain more sulphur in the form of iron pyrites than others, and thus form more iron slag or clinkers and stop the air supply unless the fireman keeps his bars clear. It is probable that the most satisfactory results are obtained in glost firing rather by a short period of reducing fire, followed by a considerably longer one of oxydising, than by a continuously oxydising flame during the whole firing, and therefore the fireman should allow his mouths to burn down quite clear and bright before again baiting, always taking care that the fires are not allowed to burn down so low as to reduce the heat in the oven. The cooling holes in the oven may also be opened for a short time as a fresh baiting is put on, and this would at once increase the draught and quickly get rid of the smoke and dirt from the freshly introduced coal. "Sulphured ware," which has somewhat the appearance of a frosted window, is caused usually by burning inferior fuel.

It is the custom with some firemen to draw their fires when the firing is finished, with the idea that it increases the brightness of the glaze, but it is always better to let the fires die gradually down, as the cold air does not then rush in so quickly, and there is less likelihood of damage to saggers and big pieces of ware such as basins and dishes. For the same reason the clamins should not be

pulled down at once, unless for some special reason the ware is required for urgent orders. If the doors of the cooling holes in the crown are opened as soon as the firing is over, and the clamins are pulled down and the mouths punched and cleaned some six or eight hours afterwards, the oven can be drawn in about twenty-four hours, which is, as a general rule, as soon as it will be required. Care must be taken in glost ovens never to go to a greater heat nor even to the same heat as that to which the ware has already been subjected in the biscuit oven, or under the softening influence of the glaze the ware will bend and great loss will result.

An oven drawing water has already been referred to, and there is no doubt that moisture drawn from the surrounding soil is most prejudicial to almost all glazes; so that glost ovens built in the proximity to springs or streams should be looked on with grave suspicion. It will be found that when any part of an oven has been repaired in the mouths or flues, that part will fire more quickly owing to the flues, &c., being smoother and the draught therefore better; and so the fireman should bear in mind which part of his oven has been fettled. It is always best to be on the safe side in glost-firing and go full hard; a piece or two may be bent, and the colour in some piece may be slightly faded and not come out quite so brilliant as desired, but this is far preferable to short fired ware, which is always dull-looking, and, although showing no defect when drawn from the oven, may afterwards craze in the warehouse. Of course the fireman must bear in mind the position of the colours in the oven, and if there are a lot of delicate colours and fragile pieces in the oven, it is clear he cannot go so hard as he would under other circumstances.

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CHAPTER XXII.

DRAWING GLOST, AND THE SORTING WAREHOUSE.

When the firing is over and the oven cool enough, the mouths are punched and cleaned; all clinkers and ashes are wheeled away and the floor round the oven is watered and swept up; and after sufficient time has elapsed the oven is drawn in the same manner as a biscuit oven, and as a great deal of the ware is now practically finished much care should be exercised in taking the saggers off the bungs and the ware from out of the saggers, so that the pieces do not fall against each other. It is a thousand pities that pieces should have successfully passed through all the operations necessary to complete them, and then, through carelessness, should be chipped and thus rendered useless, or at any rate of considerably less value. As in biscuit, so in glost, must all pieces, whether perfect, cracked, or broken, without exception, be taken to the sorting warehouse, and for the same reasons, as the payment of the placers, dippers, and firemen most probably depends on the quantity delivered in good condition into the warehouse, and a return of the exact percentage of firsts, seconds, and lump is required to work out the value of each oven.

The sorting warehouse should be very light, so that defects may at once be seen and not passed over, and it should have plenty of floor space, so that there is ample room for classifying the ware. As the ware comes in from the oven it is merely put together according to shape for convenience sake; the plates all in one place, the cups in another, basins, dishes, &c., in another, and so on, until the whole of the ware has been brought in from the oven when the sorting proper commences.

should there be any space left between the bars and the brickwork, cold air can draw into the flues, which would render firing almost an impossibility.

"Smoked" ware, which is really the reduction of the lead in the glaze, thus turning it black, is almost always attributed by the firemen to bad or dirty fuel, but it is really due to allowing clinkers to collect, and to inattention in properly regulating the influx of air and neglect to clean out the smoke and shoulder holes. It may to a certain extent be truly attributed to the fuel, in that some coals contain more sulphur in the form of iron pyrites than others, and thus form more iron slag or clinkers and stop the air supply unless the fireman keeps his bars clear. It is probable that the most satisfactory results are obtained in glost firing rather by a short period of reducing fire, followed by a considerably longer one of oxydising, than by a continuously oxydising flame during the whole firing, and therefore the fireman should allow his mouths to burn down quite clear and bright before again baiting, always taking care that the fires are not allowed to burn down so low as to reduce the heat in the oven. The cooling holes in the oven may also be opened for a short time as a fresh baiting is put on, and this would at once increase the draught and quickly get rid of the smoke and dirt from the freshly introduced coal. "Sulphured ware," which has somewhat the appearance of a frosted window, is caused usually by burning inferior fuel.

It is the custom with some firemen to draw their fires when the firing is finished, with the idea that it increases the brightness of the glaze, but it is always better to let the fires die gradually down, as the cold air does not then rush in so quickly, and there is less likelihood of damage to saggers and big pieces of ware such as basins and dishes. For the same reason the clamins should not be

care being taken at the same time not to cut a hollow in the piece; if necessary the defect can be polished with a cork or white wood disc.

Polishing lathes are more used in the manufacture of porcelain than in earthenware, as the difference in value of the piece after polishing would hardly pay for the cost of the removal of the grain in common ware; when however large and highly decorated pieces are made, a polishing lathe is indispensable. It is best, whenever possible, to send pieces with this defect to be decorated over glaze, where the marks can be covered up and hidden.

As the women clean the ware, the head man looks over every piece to see that it is without defect, and all pieces that are firsts he puts together according to pattern and colour and shape "in count", that is to say, in quantities of an equal number to facilitate counting afterwards. All the defective ware he again classifies into "seconds", that is, ware that has some slight defect which prevents it being placed amongst "firsts" or best ware, and "lump", that is, those pieces that are cracked, or whose defects are so serious that they cannot be placed among "seconds", though in some cases an intermediary classification known as "thirds" is often made. All the defective ware should then be re-classified to show where the defects originate and to whom they are due, and the responsible parties are then called in to see the result of their inattention, want of skill, or carelessness as the case may be. It should be remembered that fire being somewhat uncontrollable, and its effects rather difficult to gauge, everyone will try to throw the blame on the firing. It is presumed that there is no radical defect in the glaze itself, and the defects that are likely to arise from this cause have already been discussed in the Chapter on Glazes, so the faults to which the sorting warehouseman

has to direct his attention are those arising during the manufacture, for which individual workmen are responsible.

Roughly, then, the defects in the glost oven will divide themselves into the following classes: (1) Defects of placing; (2) defects of firing; (3) defects of dipping; (4) bad selection in the biscuit warehouse; (5) defects of printing and painting or decorating; (6) inefficient kiln-firing.

(1) Any ware "nipped", that is, with the glaze chipped off, must be a fault of the placers (unless it has been done in the sorting warehouse), as, since it has been glazed it has only been in their hands. "Plucked ware," that is, ware with pieces pulled out of it in removing it from the stilts, is due to the use of improper or unboned supports, though it may sometimes be due to over-dipping, or to the placers not cleaning off the glaze from the bottoms of hollow ware. Crooked plates and dishes are usually due to improper rearing in the saggers; crooked hollow ware is also often due to bad placing, by overloading the saggers, or from using saggers with crooked bottoms; stuck ware is also due to the placers—though these three last defects will all occur if the oven is palpable over-fired. A single piece warped may be also due to it having, for one cause or another, received a harder fire in glost than it previously had in biscuit. Flashed and smoked ware may be also attributed to placers, both caused by the improper wadding of saggers.

(2) Firing defects are usually either from under or over firing. The former is easily detected, as the ware has a milky appearance and is wanting in brilliancy, while over-firing at once becomes apparent by a larger quantity than usual of ware that has warped and become crooked or stuck, and by the faint and washy appearance of pinks, matt blue, and other delicate colours.

(3) Short dipped ware has a rough and poor appearance and is often dry in places. Unglazed patches, called "butterflies" are also due to the dipper covering these places with his fingers, or to grease on his hands, or to the glaze not being properly distributed over the piece: this is especially likely to happen in the interior of large hollow pieces, owing to the air being imprisoned, thus preventing the glaze from touching the surface. When ware is over-dipped there are likely to be beads of glaze on the edges, and the hollows and cavities of embossed pieces will be full of glaze. The dipper's attention should at once be called to this, as it is an active cause of crazing, to say nothing of the waste of putting glaze on one piece that should be sufficient for two. Over-glazing also causes the colours in printed and painted ware to run.

(4) Bad selection in the biscuit warehouse will be especially noticeable in pinks and blues, which never come out satisfactorily if too hard ware has been used for them.

(5) Defects in printing, painting, and decorating arise from dirty colour, insufficient application of colour, too liquid colour, and finger-marks and spots of colour both on the face and back of the ware. Faded colour may also be due to the pieces not being put in the part of the oven suited to them; it being, of course, presumed that the colours have been tested and are known to be satisfactory. The expert will, however, at once be able to say to what cause it is due by comparing it with the rest of the ware of a similar colour and pattern.

(6) Inefficient Kiln-firing. Pieces will be noticed which have not taken the glaze properly when they are printed or painted, the colour standing out roughly in ridges. This is due either to the kiln man not having gone to sufficient heat to drive out all the oils used in the application of the colours, or to leaving insufficient escape for the

steam and vapours in the kiln which have thus affected the colours. Pinks and blues are the most likely colours to be affected in this manner. Besides these evident defects, there are others that should be traced to their originators, for instance, ware that has been chipped before dipping and sent on as best. Nothing is more annoying than to find an order incomplete on account of a defect like this, which should have been pointed out before it was dipped, and another piece substituted for it. If any ware is seen with spots on it, caused by dirt or iron in the glaze, the manager's attention should at once be called to it.

Any ware that is defective in biscuit should have a special mark put on it, so that when it comes through into the sorting warehouse it can be at once seen that it was seconds before it went into the glost oven. The broken and useless ware should not amount to more than 2 per cent, but the percentage of glost seconds depends altogether on the strictness or the reverse of the selection; 8 to 15 per cent should about cover it.

As soon as the oven has been sorted, the person who is responsible for the "getting up" of orders should go through the seconds and defective ware and at once order up again the necessary pieces to complete his orders.

The ware should then be carried up to the various warehouses appointed for the different classes of goods, leaving the sorting warehouse clear for the next oven to be drawn. An oven record should be kept with the duration and result of each firing both in biscuit and glost, including the quantity of ware fired, and the number of saggers destroyed, together with the percentages of firsts, seconds, and lumps and the total value of each oven. Any special circumstances, such as fallen bungs, quality of coal, state of weather, should be noted.

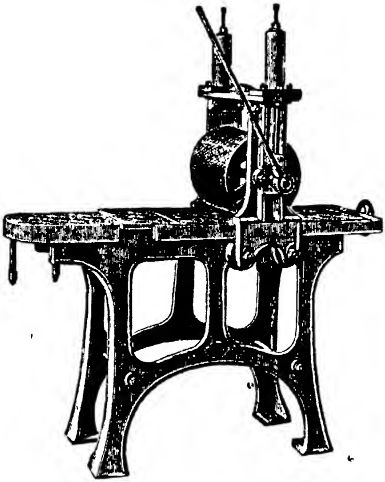
CHAPTER XXIII.

PRINTING UNDERGLAZE.

PRINTING on earthenware is a comparatively modern mode of decoration, as its introduction only dates from the middle of the eighteenth century, and it can hardly be said to have been employed to any extent till well on into the nineteenth century, but so rapid has been its development, especially during the last twenty years, that it is to-day by far the most general method of applying decoration to ware underglaze. It is the same story over again of a mechanical means to a great extent competing with success against purely manual processes, though largely assisted by the desire on the part of the consumer to have articles identically the same both in colour and design. Whether this is an altogether satisfactory development from the artistic point of view is open to question, and will be referred to again later on after a description has been given of the means employed to carry out the process.

The Printing Press consists of an iron framework which supports two hollow cylinders or rollers, between which is a planed iron bed or table on which the copper plate, engraved with the design to be printed, rests. The upper roller is furnished with screws on each side by which it can be adjusted and fixed at whatever distance may be desired from the lower one. It has a lever or handle attached to it which, being depressed, causes it to revolve, carrying the table with the copper plate on it between the two rollers. The upper roller is covered with thick flannel in either two or three layers. The flannel should be cut slightly shorter than the circumference of the

cylinder, and the ends should be laced together with string, so that, as the flannel stretches, which it is sure to do, the string lacing can be tightened from time to time in order to keep the flannel tightly in position. It is as well to have two sets of flannels to each press, so that one set may be washed and dried while the other is in use, and with care they should last about twelve months.

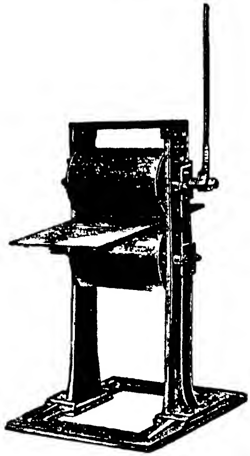


COMBINATION OF PRESS AND STEAM STOVE.

Printing Stoves or Tables.—The "medium" or printer's oil that has to be mixed with colours to enable prints to be taken off has to be kept hot during the whole process, and for this purpose the old-fashioned system was to have flat stoves with an iron bat on the top, burning either coal or slack, to heat both the copper plates and the colours.

This method was unsatisfactory for several reasons. The heat was not equal, as sometimes the stove was allowed to get red-hot, burning the colour and damaging the coppers, and at other times, after fuel had been freshly put on, the heat was insufficient; these variations in heat were a cause of irregularity in the printing. There was also always a certain amount of dirt and smoke in the shop to which the carrying in of coal and the removal of ashes contributed.

The modern tables are heated by live steam under pressure, directly from the boilers passing through a coil of pipe cast in the iron slab which forms the table, and which, after being cast, is planed smooth. The steam, after passing through the table, is received by a steam trap, which by the action of a valve prevents any steam from wasting and only allows the condensed water to escape, one trap being sufficient for several tables. Each table is made sufficiently large to serve for two printers, and as each table is fitted with an independent tap, steam can be shut off when not required, and waste is avoided. The heat being easily regulated and always equal, there is no fear of burnt colour, and smoke and dirt in the shop are done away with. If the steam is brought from any distance, the pipes should all be well cased with mud and chopped straw, or some such heat-retaining preparation, which



PRINTING PRESS.

will effect considerable economy in the consumption of steam.

Copper Plates are in most general use for printing on earthenware, though of late years many manufacturers have employed plates made of zinc as a substitute. These

STEAM TABLE.

are, of course, easier to engrave, as they are so much softer, but for this reason they wear out very soon, and the outlines are not so clean, nor are they suited to full patterns with much detail and shading. The copper

plates are about an eighth of an inch thick, and vary in size according to the pattern, or according to the pieces which have to be printed from them. They are engraved with the aid of acids or electricity, or by hand with gravers, steel points, and punches. The latter is undoubtedly the more expensive method, but it is the more satisfactory, as not only must the design be delicately and finely cut, but it must be also deeply incised, or the plate will last a very short time, as the constant cleaning off of the colour from the plate with the steel knife wears it down. The colours being metallic oxides, however finely they may be ground, are always hard and slightly vitreous.

Engraving on copper is work which requires a considerable amount of technical training, but no amount of training will make a really satisfactory engraver unless he has artistic feeling for arrangement and design. Great attention should be paid in the first place to the production of good designs, and in the second to their proper reproduction in copper with varying light and shade.

Copper plates continually wear down with work, and to prevent this some manufacturers have the plates steeled and nickelled. No doubt this causes them to last rather longer, but when once damaged they require, as a rule, more repairing than ordinary copper. Plates, however, will always require repairing and recutting, if the printing is to be kept up at a high standard of excellence. Some printers are very careless, and cut and mark the coppers with their knives when removing the colour. These marks retain the colour, and when a print is taken off the plate they appear, and thus disfigure the design and give an unsightly and dirty appearance to the ware. Every copper should therefore be examined before it is handed to the printer, and after it is done with, or at every week-end, it should be again examined to see that

it has received no unfair treatment, and if it shows signs of cutting and marks other than those that would be caused by fair wear and tear, he should be charged with the cost of repairing and damage.

If copper plates are not carefully looked after they will soon be spoilt and useless. It is surprising how soon copper plates diverge from the original design by constant repairing; so, whenever a new design is cut, the designer should always keep one of the first prints off it by him as a reference or guide for when the plate has to be repaired. These prints should all be pasted in a large book kept for the purpose, which will always serve as a reference. It is impossible to have clean and bright-looking printed ware unless the copper plates are kept in good condition, and nothing is more unsightly than coarse and dirty printed patterns.

The Paper used for receiving the print from the copper plate is a sort of thin tissue paper. It must be strong, so that it does not break when sized or pulled off the copper plate. It must, when held up to the light, be quite free from holes, so that the design is solidly printed on it, and it should have a smooth surface without any hairs on it, so that when the print is transferred to the ware the paper does not absorb the colour, but freely leaves all the colour on the ware when it is washed off. It is important to have paper of the sizes required for the different pieces and patterns, so that the waste may be avoided, otherwise large paper may be cut up for printing small patterns, and the cost of printing will consequently be increased. The paper, before being applied to the copper plates, must be sized with a mixture of 1 lb. of soft soap and 2 oz. of soda to a gallon of water.

The Colours are for the most part oxides of metals, and of late years great advances have been made in their manufacture; and there are many firms, both in England

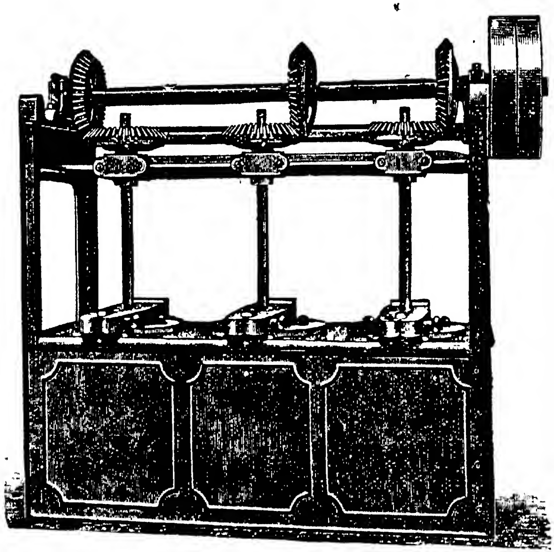
and on the Continent, who dedicate themselves solely to the manufacture of potters' colours for use both under and over glaze. Formerly every potter manufactured his own colours, but now, owing to the improvement in their preparation, good colours can be obtained at moderate prices, and where ordinary colours only are required it is probably cheaper to buy, as colour-making takes up a considerable part of a manager's time which often might be better expended in looking after the details of manufacture. Manufacturers who have colour pans will best employ them in grinding stain for the body and in the manufacture of the colours which they use in the largest quantities, as it will be found that it is not economical to make colours of which only a small quantity is required.

Modern colour pans are usually arranged in an iron framework, containing two, three, or four pans of different sizes suitable for grinding large or small quantities of materials. They are made with granite or chert nether-stones, and the grinding-stones, which are of the same material, are attached to a spindle, at the top of which is keyed a cogwheel. A shafting runs along above the pans, by which the power is transmitted. The stones must be kept in first-rate condition, as the colour must be ground to an impalpable fineness, and the wet system will be found the most satisfactory. Colour pans are also very useful for grinding experimental charges of glaze and materials, &c.

Cleanliness is most necessary in colour mills, and it is as well to grind up a few pitchers after a strong colour has been on a pan in order to thoroughly clean it before putting on another colour. Light colours should not be ground on a pan, from which a dark colour has been taken off, and it is best, when possible, to keep certain pans for certain colours. It is important that the colours should

suit the glaze, and the manufacturer who makes his own colours has the advantage of knowing of what they are composed, and all metallic oxides that will easily dissolve and flow in the glaze must be avoided.

It is not considered necessary to give recipes, as they exist by the thousand, and have been published again and



COLOUR PANS.

again. They are usually of little value except to the expert, as the success of a colour generally depends more on its manipulation during manufacture than on anything else; and unless a full description is given of the exact manipulation, very many recipes are of little or no use.

A full printed pattern would use about $1\frac{1}{2}$ lb. of colour per week.

Prices of colours must vary, but it generally costs between a half-penny and one penny per dozen of ware printed.

All colours, whether made on the premises or from whatever other source they may have come, should always be tested before they are put in general use.

Printer's Oil —For printing purposes all colours have to be mixed with what is called printer's oil, which is a thick, dark, treacly-looking substance, which causes the colour to adhere to the paper when laid on the copper plate and passed through the press. When the paper is pulled off the plate, the colour in the cavities of the copper sticks to the paper, thus forming the pattern. The paper is, in its turn, applied and rubbed on to the ware, which, being porous, absorbs the oil and colour. The paper is then washed off with water, but the oil prevents the removal of the colour from the ware. Almost every head printer has his own recipe for oil, by which he swears, two recipes are annexed, either of which will serve in their turn

(1) 1 gallon linseed oil (boil and scum for about two hours).
30 oz. Stockholm tar.
1 oz. red lead.
1 oz. resin.

Add the above to the oil, and the whole to be boiled and scummed and burnt off three or four times. A large iron pot is best for this purpose, and a round wooden flat cover with a piece of flannel tacked on, with a long handle, will be required to put out the fire after the scum has been lighted in the pot. It is best to do all operations in connection with boiling oil in the open air, or in the centre of an empty oven, as the smell is rather overpowering, and by no means pleasant.

(2) 2 quarts linseed oil.
1 pint rape oil.
1 oz. red lead.
} Boil together for two hours.

1½ oz. sulphur.
10 oz. common tar.
} Add while the oils are cooling, and stir well.

To see if the oil is properly prepared, a drop should be placed on a piece of biscuit pitcher and touched with the finger: when it gets "tacky" and sticks to the finger it is as it should be.

Printer's Knives are used for applying and removing the colour from the copper plates. They are made of thin whippy steel, about 2½ to 3 in. broad, and are ground quite sharp. They require skilful and careful usage, or the copper plates will be cut and destroyed by them. The copper plates should not always be held in the same position, but should be turned round from corner to corner, as should the printer continually start cleaning off the colour with his knife from the same corner, he would wear away the part nearest the corner sooner than the rest of the plate, thus causing unequal impressions.

Wooden Rubbers are used for rubbing the colour over the copper plate to thoroughly fill the design.

A corduroy Boss, or small cushion about 8 in. long and 3 in. wide, is employed to clean the plate after the bulk of the colour has been removed with the knife. The plate is thus left quite clean, the colour only remaining in the engraved part.

A long-haired Brush is required to size the paper with.

The Benches for printers to put their coppers, colours, &c., on should be arranged at a convenient distance from the steam tables and presses.

The Transferers will require:—

A Tub for every two presses, with a good supply of clean, cold water, the cooler the better, as the paper is washed off and the colour not softened as it would be were warm water employed.

Sponges, which need not be of very good quality, to wash off the paper, and a piece of pumice stone to rub off any spots of dirt or colour that may have accidentally soiled the ware

Flannel Rubbers, which are simply rolls of flannel of about twelve thicknesses tightly rolled up, about 13 in. long, and whipped about 10 in. up with thick packer's string, leaving at one end about $2\frac{1}{2}$ in. of flannel, and at the other end about $\frac{1}{2}$ in., hollowed out, in which the thumb can rest. A yard of flannel will make two rubbers, which should last about three months, as, when they wear down, the string can be gradually unwhipped. They require to be dipped in a little soft soap to make them slip smoothly over the paper, and not to ruck it up when rubbing it on the ware. A few small pieces of flannel are also useful for the same purpose.

A considerable amount of bench room is required, and on the bench opposite each transferer a leather pad should be nailed, on which she can rest the ware.

A pair of large Scissors is also required to cut the paper prints.

The printer's team consists of a man who does the printing, and three women or girls: the transferer, who is the head woman, places the pattern in the proper position on the ware, and presses it slightly on; the apprentice, who rubs the paper firmly on to the ware; and the cutter who receives the paper from the printer and cuts out the various pieces into the necessary shapes to fit the ware, and removes any superfluous paper.

Having mentioned the various appliances, we will proceed to describe the process.

The printer first takes his paper and cuts it to the necessary size for the pattern or plate he is using, and then with his brush sizes the paper over. He then places the copper plate on the steam stove, his colour having

also been previously placed on the stove on an iron palette or "Batstone". The copper plate being sufficiently heated, he takes some colour on his knife and puts it on his copper plate and rubs it in with his wooden rubber.

The colour should be used of a stiff and not too liquid consistency; this makes the work harder, but it ensures good printing; if the colour is used thin the pattern is printed more in oil than in colour, and after firing it will have a faded, wishy-washy appearance. He then removes all the colour from the copper by scraping it with his knife, being careful that the edge of the knife does not catch in the engraving and cut and spoil the plate; after which any remaining colour is cleaned off with the corduroy boss, leaving the plate quite clean, though the pattern is filled with colour. He next places the copper plate on the iron table of the press, and as the plate is very hot, he has a small piece of leather with which he can lift it up comfortably, and he then deftly takes up a piece of the wet sized paper and lays it over the copper plate, care being taken that there are no wrinkles. The lever handle is depressed, the upper roller revolves, carrying the iron table and the copper, with it between the rollers, and the paper is thus firmly pressed by the flannel covering on to the copper. The handle is then reversed, and the copper comes out of the press again with the table, the paper being now quite dry from the pressure of the flannel on the heated copper. The paper is lifted up carefully at one corner and pulled off the copper.

The printer has then to repeat the process. The paper is taken by the cutter, who cuts it into the shape required and hands it to the transferer; she applies it to the proper place on the ware, and slightly rubs it on with a bit of flannel, and then passes it on to the apprentice, who rubs the paper firmly on with the rubber dipped in

a little soft soap. This requires very thoroughly doing, especially in the case of fluted or embossed work, so that the pattern is rubbed right into all the cavities. A stiff brush is often used under these circumstances instead of the rubber, with satisfactory results. It is best to leave the paper a little time on the ware before washing it off, and as a rule it is left till the evening, when all the women wash off the day's work together, though it is better not to wash it off till the next day, as it thus gives the ware more time to absorb the colour, and this is especially necessary should the biscuit ware be rather hard fired.

Each printer should be furnished with a small copper plate with his number engraved twenty or thirty times or more on it, which he can print off every now and then, and every piece printed should bear the printer's number, so that there is never a doubt as to who is responsible for the work.

Cleanliness is most important in the printing shop, and the transferers should always keep their hands clean; nothing looks worse than ware with smudges of colour on the face or back of it, due to the transferer's fingers. Tubs, benches, and utensils should all be kept clean, and all copper plates should be cleaned every week, before being looked over, with sawdust and rectified spirits of tar. Patterns of which large quantities are required should be engraved on two or more plates, and the plates should never be allowed to "get down", but when partly worn should be repaired, so that the tone of printing may always be equal; otherwise, if a plate gets much worn and ware is printed from it, and then after the plate has been newly cut more ware is printed from the same order, the tone of colour will be quite different, and will not match. It is always best to use newly cut plates for the more delicate colours, such as matt blue, mauve, and

pink, whenever possible, and afterwards, when slightly worn, for the stronger browns, blacks, and dark blue.

It has been seen that the printer can only take one impression off a copper plate at a time, and then has to go through the whole operation of filling it again with colour, &c., and for this reason it is necessary for economical working to arrange the patterns on the plates so that enough pattern will come off at each printing to decorate several pieces of ware.

Care must therefore be taken in deciding on new patterns that, besides being effective, they can be arranged in a suitable manner on the copper for working. Formerly, patterns were designed in such a way that it was necessary to have a copper plate for every individual piece, and thus to print a full dinner service twenty to thirty coppers were required; with proper arrangement four or five coppers should now be sufficient for doing the same work, as the patterns most in demand are sprig and flower patterns, which lend themselves readily to every class of piece, and thus one copper will suit several different purposes. If, in arranging a pattern, pieces of sprig, &c., have to be cut off, it is well to see if these bits cannot be applied to some other ware, such as bowls, basins, &c., which is of advantage both to the manufacturer, as he uses up prints which would otherwise be wasted, and to the printer, as he thus does more ware with the same amount of work. A well-engraved copper, with ordinary work and proper care, should last six months.

Various forms of presses other than that described have been or are in use, some with the steam table in combination with the press, others by which a continuous pattern is printed on lengths of paper by engraved copper rollers in a similar manner to that by which cotton goods are printed; but none of them have come very largely into use, and the one described is the simplest, and probably

under present circumstances the most useful. There are various applications of printing, by the arrangement of parts of patterns engraved on different plates, from which different colours are printed, and then transferred one after the other on to the ware; they require, however, very nice adjustment and delicate treatment. Chromo-lithography has also been largely brought into use, and more successfully on the Continent than in England, and in the next few years there will no doubt be great strides made in mechanical decoration.

Up to the present, most of the new methods proposed are for overglaze decoration, and this can never be so satisfactory or desirable for ordinary commercial purposes as underglaze. Underglaze decoration is practically indestructible, and though the colours are fewer in number than those that can be applied over glaze, their appearance is far superior. They have a deep rich colour, and one seems to be looking into them, more than at them, and they give much the same impression as when looking at a cut precious stone.

There is always a strong party agitating against the introduction of mechanical means on account of its tendency to kill individuality; and to a certain extent this is true: but on the other hand, as a printed pattern can be produced in an almost indefinite quantity, considerable time and money can be profitably expended in producing a really good design, and surely a really good design executed in a satisfactory manner is better than a design executed by hand which probably has only the individuality of inferiority. The ordinary painted ware issuing from the English manufactory to-day is practically a reproduction of some pattern given as a sample to be copied, and the individuality usually consists in mistakes in copying it! The same argument would hold equally good in the manufacturing department, and instead of

having articles made from carefully designed models every workman would be making pieces according to his own ideas. For one man that can make a good design or shape, it is evident that there are hundreds that cannot do so, and as the majority of work would be done by them, the standard of the quality of the production would certainly be very much debased. Unfortunately, every man is not an artist, and who would prefer some "pot-boiler's" crude, badly-executed daubs to a well-engraved proof copy of a really fine picture? This is perhaps carrying the matter too far, but at all events it shows that there is something to be said on both sides of the question, and that mechanical reproductions are not necessarily bad because they are mechanical.

CHAPTER XXIV.

PAINTING AND DECORATING UNDERGLAZE.

WHATEVER may be the development of mechanical processes for the decoration of earthenware in the near future, it is evident that they never can replace the hand-painting of a really skilful artist, and though various mechanical processes will undoubtedly be applied more and more every day to the larger production of goods for purely commercial purposes, which must be manufactured in enormous quantities and sold at low prices, their absolute and monotonous correctness will rightly militate against their introduction into really artistic work, in which *price* has not always to be the ruling factor. There are, however, many applications of hand-painting in its lower grades which are still largely employed on the cheaper qualities of earthenware underglaze. No system of decoration can be considered as applicable to earthenware that is not afterwards subjected to heat to fix it to the body or glaze, and the colours must therefore be arranged to resist the heat to which they are to be subjected, or to change their tone in a definite proportion to that heat.

The colours for underglaze painting are practically the same as those used for printing, and are more limited in number than those for overglaze work, as the heat to which they are subjected in firing the glaze is much greater than in the enamel kiln. The melting glaze has also an effect on many colours, so that any colours that would dissolve in the glaze cannot be used. As, however, the colours suitable for underglaze work include blue, black, brown, green, yellow, and pink, the palette of the

underglaze painter is sufficiently ample; in fact, the multiplication of colours of late years has been rather detrimental than advantageous to underglaze decoration, as it has inclined the artist to look for his effects to elaborate arrangements of colour rather than to boldness and freedom in design.

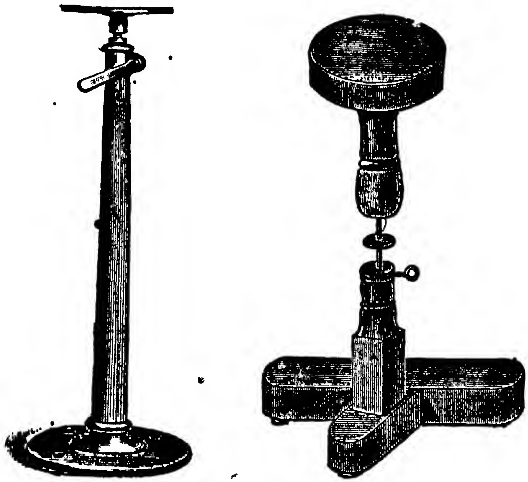
The Colours must be finely ground in the colour pans as for printing, and the water then thoroughly dried out of them, but before being used they are again ground in the painting shop with the "medium" with which they are to be applied to the surface. The most usual medium is turpentine, but for certain classes of work gum-arabic and water may be used, the advantage of the latter being that it need not be passed through the hardening on kiln, but can go direct to the dipper to receive its coating of glaze without any further process; the disadvantage to its use being its likelihood to chip off, carrying the glaze with it, after it has been fired, should there have been too large an admixture of gum with the colour. It is only necessary to introduce just sufficient to enable the colour to adhere to the ware and to prevent it being washed off when immersed in the glaze.

The second grinding of the colour is usually carried out with hard glass or porcelain mullers on slabs of hard glass some 18 in. square, which, for greater security from breakage, may be framed in wood. Glass mullers that are soft and wear away quickly should not be employed, as the fact of their wearing away means the introduction of a considerable quantity of glass into the colour, which would probably affect the colour when submitted to heat.

Palette Knives are required to scrape the colour off the glass slabs, and they are made of thin ivory, horn, or steel; the latter are the most generally used and are really the best, though care must be taken not to scrape or grind them more than necessary against the glass,

as they thus wear down and introduce iron into the colour, which is, of course, detrimental.

Pencils and Brushes of various shapes and sizes will be required in accordance with the necessity of the work; palettes and a few pieces of rag to clean pencils, &c. One of the commonest patterns applied to ordinary ware is the combination of bands and lines of various widths



PAINTER'S TABLES.

in one or more colours. By the aid of revolving painter's tables these lines, &c., are made with considerable facility. The article to be banded is placed on the head of the table, which should be quite level and run perfectly truly on its spindle, and is centred by tapping it with the finger as the table is revolved by the left hand, till it is exactly in its centre. This seems an easy operation,

but it takes considerable practice to adjust a piece at once to the centre. The bench is furnished with a rest, which is merely a piece of board 3 in. broad and about 18 in long, fixed to the bench at the side of each worker, with a screw. The rest can thus be turned round to project from the bench over the revolving painting table. The brush can thus be applied to the ware while the hand is steadied on the rest. The table is then revolved with the left hand, carrying the piece of ware with it, while the pencil remains still in the same place, thus forming a perfectly circular and even band or line on the ware.

It is very necessary that the bands and lines should be of the same strength and width in their whole course, and that they should also be exactly equidistant from each other. Nothing looks worse than irregular and uneven banding and lining. Dishes and other oval pieces, and in fact any pieces that are not circular, are more difficult to do nicely, and should always be reserved for the most experienced hands, as they cannot be painted with the rest on the revolving table. These are usually executed by using one of the fingers as a guide, resting against the edge of the article, thus regulating the distance of the line from the edge, and great care will have to be exercised in turning any corners.

Filling up is another method of decoration largely in demand. Although the general run of printed patterns will serve very well for this purpose, light patterns—that is to say, patterns engraved with rather less shading than would be required for ordinary printing, and not quite so deeply cut—are often used for this purpose. They are printed in light brown or neutral colour, and applied to the ware as in ordinary printing. Various different colours are then painted over the different parts of the printed pattern as may have been decided on. A sample

pattern should be given as a guide, and each leaf, flower, or what not, should be coloured exactly alike in each piece. To facilitate this class of work, three or four girls work together, each one painting in a different colour, though some of them may have two or more, should the pattern require it. The piece is then handed on from one to the other, each doing her part of the filling up of the design in the colour she is using, one doing the leaves, another the flowers, a third the stalks, &c., and by this means the quantity of work that can be turned out in a given time is much greater than if one girl had to fill in the whole pattern in the various colours. Care must be taken to keep within the outline of the pattern, and the colour must be applied in such a way that the shading of the printed pattern shows through. The colour must, however, if the effect is to be good, be applied rather thicker in some parts than in others to accentuate the details and to assist in giving the effect of light and shade.

The highest form of hand-painting is, of course, when the artist designs and decorates a piece unassisted by any mechanical means or guide, but as a rule by far the greater part of the work which can lay any claim to artistic merit is executed over glaze; partly because many of the colours change their tone when submitted to the intense heat of the glost oven, and it is thus difficult for the painter to gauge the exact effect of his work, and partly because the liability to loss from various causes is greater in the glost oven than it would be in the enamel kiln.

The first difficulty can only be got over by long experience, a study of the different colours, and by keeping a test piece always in view of the effect of every colour in use in its different combinations. The easiest way to do this is to number each colour, and then paint

a band of each one across a plate or dish, and then to paint a band of each colour at right angles across the bands already painted. The piece is then fired, and by this means the effect of one colour upon another can be accurately noted, as each band of colour thus crosses all the others, and its effect on each of them is clearly shown.

Finely executed underglaze work is superior to overglaze, not merely on account of its greater durability from being under the glaze and so protected from damage and abrasion by it; but the glaze seems to give a greater depth of tone to the colour, and a richer appearance to the ware. It is true that more delicate shades can be used over glaze, but they can rarely have the rich, glossy appearance of underglaze work, though some of the most charming effects are often obtained by a combination of both under and overglaze painting.

There are many other means of decorating ware cheaply under glaze; for instance, various patterns and figures can be cut out in stencil plates of oiled paper, thin metal, lead paper, &c., which are held firmly on the ware, and the colour is then rubbed over with a stiff brush. Patterns such as crosses, stars, butterflies, &c., may be cut out of the root of sponges or corks; they are then dipped slightly in colour moistened with gum water, and lightly pressed on the ware. Designs are often pricked out with a pin on paper, and the paper is then laid on the ware and pounced over with powdered charcoal; this leaves the design outlined on the ware to serve as a guide, and can easily be filled with the necessary colours. Pieces may be dabbed over with an ordinary small sponge with either one or more colours, giving them a marbled or mottled appearance, &c., &c.

CHAPTER XXV.

HARDENING-ON KILNS.

It has been mentioned several times in the course of these notes that all ware which has been printed or painted with colours mixed with any greasy or oily medium has to be dried at a heat sufficient to evaporate these foreign substances from the pores of the ware, so that it has resumed its absorbent properties, and on being immersed in the glaze it will receive an equally even coating all over the piece. This is called "hardening on", really a complete misnomer, as after the ware has been submitted to the heat, the oils used in applying the colours being driven off, leave the colour on the pieces in its original state of impalpable powder, which will come off if touched with the finger ever so lightly, and care must be exercised in handling it before dipping to avoid smudging it. To thoroughly dry out these oils it is necessary to raise the temperature of the ware to a red heat, and to obtain this object kilns are employed.

Kilns, both for hardening on and for enamel or overglaze purposes, are built on much the same principles, the former, however, usually being considerably larger. A kiln is simply a fire-clay box into which pieces of ware may be introduced, and which can then be surrounded by fire and heated to the necessary degree without the pieces of ware coming directly in contact with the flame. The shape of a kiln may be compared to a railway tunnel, that is to say, it is formed by an arch supported on sides which are not quite perpendicular, but slope slightly inwards, so that the breadth at the bottom is slightly narrower than the breadth at the point from which the arch springs.

In building a kiln it is first necessary to secure a thoroughly firm foundation and then to decide on the size of the kiln to be built. This will depend on the quantity of ware that is to be fired at one firing, and must be governed by the rate of production of the printing and painting shops, and moderate sized kilns will usually be found the most useful. If very large kilns are used, it will often be found that there is not sufficient ware to fill them, and they either have to be fired partially full, which is waste of fuel, or they must wait over until the next day for more ware, which is loss of time. The number of the mouths will vary in accordance with the size of the kiln; formerly kilns were built with one mouth from the back to the front, the flues working through the top of the mouth arch, which was the system specially advocated in France, but now, by a different arrangement of the flues, the mouths are constructed at the side, by which means much greater regularity of heat in all parts of the kiln is obtained, and there is also less destruction to the brickwork and flues, and it is therefore more economical in repairs.

The inside measurement of kilns might be somewhat as follows, though there is no hard and fast rule :—

	Height. Ft. in.	Length. Ft. in.	Breadth. Ft. in.
One-mouthed Kiln . .	4 6	2 6	2 3
Two-mouthed Kiln . .	6 0	6 0	3 0
Three-mouthed Kiln .	6 6 to 7 0	8 0 to 10 0	4 0 to 5 0

One mouth will work either two or three flues, that is to say, two or three flues under the bottom and round up the far side, and an equal number up the near side to the crown. A large kiln with three mouths will require six or seven flues both up and round, and may be built with more.

When the size has been decided on, the outer case or shell is built of ordinary brickwork of sufficient size to contain the kiln and the necessary flues, and built in such a way that the interior sides, when faced with fire-brick, will form the back of the flues; so that very careful measurements must be made before starting to build so that the flues are of the proper size. Rising from this outer shell will be the stack, which should be from 20 to 30 ft. high. A manhole must be left in it just above the level of the top of the kiln, to enable the kilnman to get on to the top of the kiln in case of the stoppage of a flue, or to alter the height of the small interior chimneys. It will be found to be a considerable economy to build kilns together in pairs, and thus the same stack will serve for both, and the mouths can be on opposite sides.

It is advantageous in building this outer shell to build in old railway iron or steel rails placed upright at the corners or in other suitable positions, and to bolt them together from side to side with iron ties. The usual custom is to build the shell, and then put cast-iron plates against it, and tie it round with bonts. This is more expensive, as old rails can generally be bought cheap, and their use is certainly more satisfactory, as, being built in the brickwork and tied through it, they hold the kiln frame solidly together and prevent the brickwork from moving or cracking. A rail may also be bolted in the brickwork horizontally across the top of the mouths, which will much increase their duration, as it prevents the fire-bricks in the arches from falling out of their places. The mouths may be built flush and baited through doors or an arch as in a glost oven, or they may be built with hobbs as described under "Oven-Building", and the latter construction certainly works admirably in kilns.

Two flues are the usual number running out of each mouth. Two of them will then run from the mouths,

under the floor, and up the far side of the kiln, and over to the crown of the arch, while, in the other direction, they will run up straight from the mouths on the near side of the kiln, also to the crown. Horizontally along the top of the crown runs a trough-like flue into which the other flues run. This flue is furnished with two or three small chimneys a foot or so high, and by slightly decreasing or increasing the height of these chimneys, the draught from the different mouths can be regulated to obtain an even heat all over the kiln. There is often a small flue leading from the end mouth to the back of the kiln, which, if properly built, should be tied through with fire-bricks from the outer case to support the back of the kiln proper, thus leaving spaces through which the heat can work. And under these circumstances the back will "come up" first in firing, and probably part of the fire will have to be drawn before the rest of the kiln is fired up. Backs are, however, sometimes built up solid against the outer case: which, however, is not so good. The back flue usually runs straight into the stack and not into the horizontal flue on the top. Should there be no back flue the back mouth should have three flues running up the side and under the bottom.

Flues are generally about 8 or 9 in. square and should be arranged at equal distances apart; but if they are put in with ordinary flat backs they would not be more than 6 in. The medfeathers which form the flues under the bottom on which the bottom quarries rest, and which form the flues at the sides against which the kiln sides rest, are generally ordinary 4½ in. bricks (of firebrick, of course) as must be all other brickwork in contact with the fire, and it must all be laid in fireclay with an admixture of 10 to 15 per cent of sand or grog, as in oven work, the joints always being made as small as possible. Care must be taken that the joints of the

quarries and sides always come well on to the medfeathers. The quarries for the sides of kiln should be about $1\frac{1}{2}$ in. thick, 6 to 8 in. broad, and 12, 14, or 16 in. long, the bottoms being $2\frac{1}{2}$ to 3 in. thick, 12 in. wide, and of the same length as the sides. Both sides and bottoms are grooved and tongued all round so as to fit closely into each other, and they are started off the bottom from specially made "burs" having a ledge on one side on which the bottoms rest, and being grooved on the top to receive the sides.

In *boxing* a kiln, when the medfeathers forming the flues have been built, they should be thinly coated with stiff fireclay; the quarry or kiln side should then be dipped in water and pressed on to the medfeather, where it will stick and remain fast while the rest are being placed in position. Each quarry as it is placed should have the groove or tongue coated with a little fireclay to make a firm joint, care being taken to make it as small and close as possible; then when the sides have been built up the quarries are fitted in, arching over towards the crown, and at the crown the last two quarries are fitted exactly and cut to the correct size, if necessary, to fit up to the medfeathers, and at the same time wedging the arch firmly against the sides. When they are arranged exactly to size they are slipped into the grooves and firmly driven home with a wooden mallet.

Kilns require constant attention, and probably some of the joints will require stopping after every firing—which may be done with turners' shavings, refuse from the lawns in the slip-house mixed with sand and a little fireclay, or with one of the many patent kiln stoppings specially made for the purpose, some of which answer the purpose very well. A kiln that is in constant use, and is fired and drawn as soon as may be, should last from four to five months without any radical repairs, if properly

constructed and accurately boxed in the first instance. Kilns often have iron doors, but it is not really a necessity, as they can equally well be built up with firebrick in the same way as the clamins of an oven.

Placing.—The ware all being in the biscuit state can be piled up one piece upon the other, as long as the colour on one piece does not come in contact with another; dishes, plates, &c., are kept apart by small biscuit supports called "nibs", the important point being to get as much ware as possible into the kiln. It should be piled up in such a way that it will not fall during the firing nor while it is being drawn. Some kilnmen use props and bats in a hardening-on kiln as they would in an enamel kiln, but there is really no necessity for this, unless the kiln is so exceptionally large that the weight of the ware would be likely to crush or crack the pieces at the bottom.

There is little art in *firing* hardening-on kilns, and almost any fuel will answer for the purpose, small coal and an admixture of slack being quite sufficiently good. There is no occasion for trials, the colour of the interior being quite sufficient guide, and when the heat has reached a dull red it is sufficient for the purpose, and the firing may be stopped. Care must be taken to leave plenty of vent for the exit of the vapour from the oils and for the steam from the water; the latter exists in considerable quantities, as in washing off the paper from the printed ware the pieces absorb a considerable amount of water, and should this steam be shut in, it is very likely to affect the colours, especially the more delicate ones, such as pink and matt blue, causing them often after the glost fire to stand out in rough ridges as if insufficiently hardened on, or giving them a milky, washed out appearance, as if they had been carelessly printed. The clamins should therefore be left open for

some time—in fact, the kilnman can always light his kiln before he has finished placing it—and by this means the ware is drying before the clamins are built up and considerable time is saved.

Drawing.—Kilns may be cooled rapidly as soon as they are finished, though a certain amount of time must be allowed if there are many large pieces, such as dishes or basins in the front, to avoid dunting. The kilnman must be careful in handling the pieces, when taking them out of the kiln, not to rub the colour off them, nor to smudge them by getting colour on his fingers. Nor should they be sent to the dipper when hot, as in this state the absorption would be greater, and they would receive a thicker coating of glaze than desirable.

Insufficiently hardened-on ware can generally be detected when drawing a kiln, as the colours after firing should have a dull matt appearance; if they look at all glossy the oil has not been properly driven out. After the glost fire it shows unmistakably, as the parts where any oil remains will not be glazed, will be blistered, or will be covered with small holes known as "pinholes".

CHAPTER XXVI.

PRINTING, PAINTING, AND DECORATING OVERGLAZE.

Printing over the glaze is carried out in a similar manner to that described for underglaze, but it is more often used for printing the outline of designs which are afterwards to be filled in by hand than for fully engraved patterns. It is also largely employed for badges, crests, initials, &c.; letters, &c., being sometimes printed in the necessary colour, and at others in oil on which the colour is afterwards dusted by hand. In the latter case gelatine films are sometimes used to effect the transfer. As this class of work is usually not required in such very large quantities as ordinary underglaze printing, zinc plates are very generally used in preference to copper, as they can be more quickly engraved, and their durability is not such a very important point.

The chief advantage of doing this class of work overglaze is that, as the ware has been through the processes where defects are most likely to occur, there is less chance of pieces coming out defective, as the percentage of loss in the enamel kiln should be very low, and should a piece come out defective, it can be at once reprinted or repainted and passed through the kiln again in a few hours. For this reason it is as well to have a little overglaze colour as nearly the same tone as possible as the underglaze colours generally in use, and then if some piece in underglaze printing, which is urgently required to complete some special order, comes out defective, it can be printed up overglaze and the order is thus matched up and not delayed.

The great disadvantage of all overglaze work for ware

in daily use is that with time the colour, being outside the glaze, must gradually wear off in places, whereas underglaze work, being protected by the glaze, will endure as long as the piece itself, and therefore, from the potter's point of view, underglaze work is the finest production of the two. Printing may be done overglaze with underglaze colours and then passed through the glost oven. This will save time when a piece or two are wanted to complete, as the ware has not to be hardened on ; but it thus has two glost fires, which, of course, increases the expense.

The Colours in use overglaze are innumerable, and as the heat at which they are fired is not excessive and will not probably exceed 1,500° F. in ordinary kiln firing and 1,800° F. in hard kilns, the most delicate shades of oranges, reds, and pinks can be obtained. Overglaze colours are mixed with a proportion of flux, which is really a soft glaze which melts during the enamel kiln fire, thus fixing the colour firmly to the glaze. They are therefore made from two perfectly different substances—the colour basis and the vitrifying flux. Fluxes have to be made of various ingredients to suit the various compositions of the colours they are to accompany. The materials are calcined in special kilns or fritted together, ground fine on the colour pans, then thoroughly dried into powder, and mixed in the necessary proportion with the colour. As an instance of a flux, the following may serve :—

Red lead,	3 parts	Treated as above.
Borax,	2 ,,	
Flint,	1 part	

Fluxes may be calcined in a glost oven in small bowls, if only a small quantity is required ; the bowls should only be half filled to prevent boiling over, and should be first washed both outside and in with flint-slip, and

they should then be bedded in a sagger in dry flint. A space should be left between the saggers, or a hole should be made in the side of each sagger at the top. Fluxes require very nice arrangement to suit the different colours, as they really play a double part in fixing the colour to the ware, and at the same time in glazing and giving a brilliant and glossy appearance to the colour. Should matt colours be required, merely sufficient flux must be introduced to fix the colour without glazing it. The introduction of borax into colour-making has been of great service, as it to a great extent takes the place of lead, more especially red lead, which has a bad effect on some of the more delicate colours, such as pink and purple, giving them a yellowish tinge.

Before referring to painting overglaze with ordinary enamel colours, some mention should be made of oxide of cobalt or oven blue. This blue is unaffected by great heat, and can be painted on the glaze, and may then be passed a second time through the glost oven, when the colour combines and sinks into the glaze, producing a magnificent effect. Oxide of cobalt is suited to most glazes, as it is unaffected in appearance by the presence of vitreous matter, and resists the greatest heat that is attained in ovens used for commercial purposes. Should the piece, however, to which it has been applied, be overglazed, it is likely to flow a little. It may also be used on biscuit and be hardened on and dipped in the same manner as underglazed colours, but with proper treatment it seems to give even better results employed overglaze as described.

Painting Overglaze with ordinary enamel colours is an easier process than underglaze work for several reasons. The surface to be painted on is smoother, though some do not consider this an advantage ; it is non-absorbent, and so different effects can be tried, alterations made, and

colour removed which would be impossible in the case of biscuit, and the variety of shades and tones of colour is far greater than can be obtained underglaze. The colours only change slightly when submitted to heat, and so the artist can get a far better idea of the effect his work will have when finished. He should, however, always keep by him fired trials of all his colours, so that he can judge of their exact tones after the kiln fire.

Unfortunately, until of quite recent date, overglaze painting has been largely under the influence of some of the Continental schools which studied only elaborate detail in their work, in fact a sort of miniature work on china, and for many years past most overglaze work has had a laboured finicking appearance. This elaboration of detail may be suited to certain classes of work, and there is certainly nothing to be said against fine finish when coupled with boldness of design, as in the case of the Chinese and Japanese; but in the general run of European overglaze work design has been completely sacrificed to detail. During the last few years there have been signs of a desire for broader and bolder treatment, especially in articles that are for use as opposed to those which are only for ornamental purposes, and it is to be hoped that the movement in this direction will continue.

The colours have to be ground and treated much in the same way as underglaze colours, and the usual medium for applying them is *fat oil,* which is procured by placing turpentine in saucers one above the other and keeping them in a warm atmosphere protected from the dust. The turpentine gradually evaporates, leaving a thick, greasy, unctuous residue which can then be placed in a wide-mouthed glass jar till required for use. Some painters make their fat oil by adding one part of Stockholm tar to two parts of turpentine; but the first mentioned material is the cleaner. There are so many good colour

manufacturers to-day that it certainly does not pay the ordinary commercial potter to manufacture his own overglaze colours, unless there is some particular colour he uses in large quantities, or unless he wishes to obtain some effect which he cannot arrive at with the colours to be bought in the market. Overglaze colour-making takes up a very great deal of time, and unless there are ample facilities and apparatus at hand it is difficult for the general potter to produce each batch of colour exactly identical with the previous one; whereas the colour manufacturer is continually producing quantities of the same colour and can thus always turn out an exactly regular article. Expert manipulation is the basis of success in colour-making, and without it the best recipes are of little use.

All colours should be carefully tested before use, as there is no doubt that some colour-makers are careless, to say the least of it, in exactly following their samples, and it should be borne in mind that one can buy at too low a price. If colours are offered at such a price that it is evident they cannot contain the proper ingredients, the result of their use will certainly not be satisfactory. It is true that the colours will seem to cost slightly more to buy than if made on the pottery, but if a colour does not turn out as it should, in the latter case the time and materials are lost; whereas in the former case, if the colour, on being tested, is unsatisfactory, it can, of course, be at once returned to the maker.

Price is certainly of very great importance, and trials from various makers should be made before deciding which are most suited to the various purposes. It should be noted, when selecting colours from samples that have been fired, on what sort of body they have been printed or painted. Colours always look more bright and brilliant when applied to china than when applied to earthenware,

and the heat at which they have been fired will greatly affect their tone, and the greater the heat at which the ware is to be fired the more care is necessary in the selection of colours.

Overglaze colours to be really good should have the following qualities :—

They should always fuse at the same degree of heat, and should not change in tone; though, however carefully arranged, there will always be some colours that require a greater heat than others.

They should adhere firmly to the glaze and should, unless they are intended to be matt colours, have a glossy, brilliant appearance, as like the glaze as possible.

They should not be affected by humidity or changes of temperature.

They should have the same expansion and contraction as the surface to which they are applied.

They should fuse at a lower temperature than the glaze to which they are to be applied, and should be sufficiently hard to resist being rubbed off or scratched when in ordinary use; and they should not be affected by acids, oils, or gases used or given off in the preparation of food, &c.

All colours both under and overglaze should be kept in covered jars in a thoroughly dry place. Each jar should be numbered, and there should be placed inside each jar a small piece of ware with some of the colour on it that has been fired to show its effect. A book with corresponding numbers should be kept, giving full particulars of ingredients, origin, cost, &c., of each colour. Colours are often very similar in appearance before being fired; but by proper attention to numbering all chance of error is avoided.

Colours should always be weighed out to each painter or group of painters, so that the amount of colour required

to do a certain quantity of ware may be known and waste avoided. This is very important, as some colours, such as purple, are most expensive.

The overglaze painter's requirements are very similar to those of the underglaze painter. Brushes of various sorts, grinding glass, and muller; palette for colours, which is usually a square tile with small round holes into which the semi-liquid colour can drain; a revolving table for lining, &c. The greatest care is necessary in cleaning mullers, &c., after grinding one colour before commencing to grind another; and all brushes, palettes, &c., should be kept covered when not in use, to avoid dust. In fact, dust falling on partly finished work or on colour is very likely to cause small holes in the colour after firing.

Every class of work is carried out overglaze from the simplest band and lining to the finest flower and bird painting, from the roughest lettering to the most intricate heraldic badging. In fact, in overglaze painting there is nothing to interfere with the production of the finest works of art, as the change of colour during firing is small and easily allowed for, and losses in firing are comparatively small. It is, however, true that some colours might have to be fired before others can be applied, still it is rather surprising that so few artists of note outside pottery circles have made use of a process which is practically indestructible, and from which the colours will never fade.

One of the chief reasons that the painting on earthenware is at such a low ebb, is that the workers are put to it without any previous knowledge of designing or drawing, and as for the most part it is necessary for them to earn wages as soon as possible, when they can once do some simple pattern they keep on repeating it with only trifling variations, as by this means they can

get through more work. They therefore have no chance of working at a variety of different subjects to get an idea of design and arrangement, and the consequence is that there is very little real originality to be seen in pottery decoration.

Ground Laying or Oil and Dusting is a very common method of decorating when large coloured surfaces or broad bands of colour are required. The piece or part of the piece which it is thus desired to decorate is coated with oil. The oil must be laid on very evenly and as smoothly as possible. A specially prepared oil is used, which may be made as follows :—

2 quarts linseed oil 1 oz. gum mastic $1\frac{1}{2}$ oz. red lead 1 pint turpentine	Boil together for about a couple of hours.

After the piece has been smoothly coated with oil, dry colour is powdered on with a piece of cotton wool. The colour should be very dry and perfectly ground or the surface will not have a nice appearance. The work should be done where there is no draught, so that dust is not blown on to the surface, nor is the colour disseminated in the air and breathed by the operator. With some colours it will be found necessary to fire the piece two or three times, and before each fire to ground-lay it again till the necessary tone of colour is obtained. If in ground-laying a piece, the colour is at all patchy, it is best to clean it off and start the process again, as it is difficult to touch up and will always have the same patchy appearance after firing.

The selection of colours for ground-laying requires care, as they have rarely the same glossy appearance when treated in this way as when applied with a brush. Grounds may be laid lightly over printed patterns so that the design shows through after firing, or spaces may

be left like panels, &c., on which painting can afterwards be executed. It is always better to leave any spaces that are to be painted on afterwards white, as painting on a coloured ground will always more or less affect the appearance of the colours.

The ærograph will probably have a considerable effect in ground-laying. This machine consists of a very fine sprayer worked by compressed air, and gradations of tone and evenness of work can be obtained with it probably superior to the best hand work.

Metals are largely used in the decoration of earthenware, especially gold, silver, and platinum. The former is the most effective and is the most generally employed. The ordinary method in the preparation of gold used to be to grind it up with a muller on a glass slab with prepared oil, gum-water, or some other sticky substance, and when thoroughly ground it was applied with a brush. Now, however, it is usual to make an amalgam of the gold with mercury and then to grind it up in the same manner with turpentine. When applied to the ware with a brush it has a dark brown appearance, but after the fire it becomes a golden colour but matt, and must be polished with bits of agate or bloodstone set in suitable handles if it is desired to give it a polished brilliant appearance

Of late years a chemical production containing a proportion of gold held in suspension in liquid has come into general use; it is known as brilliant or liquid gold. It is merely painted on the ware, and after it has been passed through the kiln it has a brilliant glossy appearance without being polished. For this reason and also on account of its lower price it is largely used. Should it have a slightly dull appearance on coming out of the kiln, it may be cleaned and brightened up by rubbing with a little whitening, either dry or moistened

with water, and a piece of rag, and afterwards polished with a cloth. Great care must be taken not to spot or smudge ware with the gold as these marks, after being fired, will become purple, and it takes a good deal of time to clean them off with acid. It is needless to say that gold must be very carefully weighed out, and an account kept of the quantity of ware decorated with it. All pots, palettes, and rags used for gold or for cleaning brushes or wiping off spots should be kept, and at certain fixed intervals all utensils should be washed with acids and the rags burnt and the gold recovered.

Raised Work may be executed in white enamel paste and passed through the kiln; it can then be gilded or coloured and refired.

Transferring.—Of late years a system has been invented of transferring patterns, prepared in various combined colours, to compete with "filled in" ware. The patterns are prepared by skilled artists, and thus each impression is most admirably executed, and the light and shade has a charming effect, and there is, of course, no colour outside the outline of the pattern, as is often the case with "filled in" ware, unless it has been most carefully executed. Its cost is, however, slightly in excess of filled in ware, and the colours are hardly so brilliant, and it, of course, suffers from the same disadvantage as all other overglaze work, in that with use it will wear off. Underglaze transfers are, however, also being made, but up till the present the results have not been sufficiently satisfactory to bring them into general use.

The process is a simple one, as the pieces are sized over with a special preparation, and they are left till the size becomes sticky or "tacky". The patterns are cut from the sheets in which they are manufactured, and applied to the ware, pressed firmly on, and rubbed over with a small flannel roller attached to a handle to impress the

pattern closely to the ware. The patterns, once applied to the piece, must not be moved, and care must be taken in rubbing them on that they do not slip along the surface of the piece, or they will be blurred. The pieces are left for a short time to allow the design to stick to the size, and then the paper is washed off and they are passed through the kiln, which fixes the pattern to the glaze. There will no doubt be developments in this process, but at present it cannot be considered as altogether satisfactory, though great progress is being made in it, and much very pretty work has been executed by it, more especially in France and Germany and on the Continent.

CHAPTER XXVII.

ENAMEL KILNS AND FIRING.

Construction.—Enamel kilns are built in a similar manner to hardening-on kilns, but are usually rather smaller, as different colours require different heats, and with small kilns it is easier to get together sufficient of the different suitable colours to fill them. The size of the kilns should, however, depend on the rate of production of the decorating shops, and the proportion of the different colours required for the execution of orders. As in enamel kilns considerable heat has to be obtained, large kilns will be found to be, in proportion, more expensive in repairs than small ones.

Before placing the ware in kilns they require most careful looking over; and all joints and cracks in the quarries should be stopped either with a mixture of fireclay and finely-ground grog, or with one of the special stopping mixtures manufactured for the purpose; and it is very false economy indeed not to keep kilns in a thorough state of repair. It is of the utmost importance that no sulphur fumes from the coal should obtain entry into the interior of the kiln, as the colours are sure to be affected, and many of them will be utterly spoilt. After the stopping has been thoroughly carried out the kiln should be carefully limewashed, so that if, during the firing, sulphur should get in by any new formed crack, it would be absorbed by the lime; all props and bats, whether iron or fireclay, should also be limewashed.

Placing the ware requires considerable skill and

practice, as, although the heat attained is not sufficient to melt the glaze, yet in firing some colours the heat to which it is necessary to go is sufficient to soften it, and the colours, owing to the fluxes in them, are in a fused state, and would therefore stick together if they came in contact. It is therefore necessary, as in the glost oven, to isolate every piece, and for this purpose supports and stilts are used of a similar, and in some cases identical, shape as those used in the glost oven, and the ware is arranged on them so that each piece is just clear of the next one to it.

Different colours, as has been already remarked, must have different situations allotted to them in the kilns according to the different degrees of heat; for which reason it is necessary to study each individual kiln to find out where the hottest and coolest parts are situated. As a general rule the points just at the back of the flues formed by the sides will be the hottest, and the fire side of the kiln is usually hotter than the opposite one. Sometimes the bottom or the back is one of the hottest positions, though this is rare; it is, however, clear that these details can only be obtained by experiment. The front, as a rule, is rather easy; but all these variations must be carefully noted if success is to be obtained in firing.

As a rule, therefore, the more delicate colours should be in the centre of the kiln, surrounded and protected above, below, and at the sides, by colours that will sustain the greater heat without detriment. If, therefore, delicate colours, such as coral red, flesh colour, light orange, &c., have to be fired, it will always be necessary to have a certain quantity of the stronger colours, such as brown, green, and blue, which may be placed in the harder parts of the kiln, and by which the more delicate colours may be protected.

As each piece has to be isolated by supports, it is not possible to pile up safely very many pieces one on the other; it is therefore usual to have a number of fireclay or iron slabs or bats which can be arranged on props at different heights, thus forming shelves on which the ware can be placed and the kiln thoroughly filled, and the pieces so arranged that there is little chance of their moving during the firing. Iron bats will be found to be the most convenient, as they may be made quite thin, $\frac{1}{4}$ to $\frac{3}{8}$ in. being sufficient, unless very heavy articles have to be placed on them. The bats may be perforated all over, and by this means not only will the heat be more regular through the kiln, but they will be light and easy to move when placing or drawing. The bats will want careful cleaning after each firing, and iron should be chosen that has no tendency to scale off when submitted to heat.

Bats and props should always be in good condition, and if they are well placed in a kiln they help to support the sides and make the kiln last longer; and the fall of a prop or bat in a kiln is sure to result in considerable breakage and loss. Ware should be at once placed up when carried to the kiln and not allowed to remain about to get covered with dust, which is most detrimental to the colours. If more ware than will go into the kiln has been brought to it, the excess should at once be carried back to the painter's shop or store.

Trials.—As some colours require one degree of heat, and others another, it is necessary to be able to gauge the degree of heat arrived at at any moment, and the common method is to place in the interior of the kiln as near the centre as possible, small pieces of glazed ware with a little rose colour on them. It is as well to place them a little towards the warmer side of the kiln rather than quite in the centre. These pieces of ware may either be

specially made about 2 in. square with a hole in them to facilitate their removal with the drawing rod, or they may simply be broken bits of plate, in which case they would have to be drawn from the kiln with tongs designed for the purpose. Some firemen prefer small cups, as they consider they are more thoroughly surrounded by the heat, and thus give more accurate indications than flat pieces, which are partially protected by the bat or plate on which they are placed.

The rose colour (usually purple of Cassius) is applied either with the finger or a brush; in either case the object is to make a patch of colour thick in one place and gradually shading off to nothing, thus passing through several gradations of strength of colour. The tone of colour changes as the heat increases, the parts where the colour is thinnest and lightest being the first to be affected, becoming bright, and thus giving warning of the increasing heat. The same colour should, of course, always be used, and considerable care is required in preparing the trials, as there are a multitude of small matters which may have an influence on the appearance of the colour, besides the increase of temperature. For instance, the fineness to which the colour has been ground, the medium with which it has been mixed, the thickness with which it has been applied to the ware, may all affect its change of tone. The presence of vapour or steam in the kiln, or of sulphur or fumes from the fuel, would turn the colour to a dirty violet. Keeping the kiln at one temperature a long time would eat the goodness out of the colour and prevent it acting as it would under ordinary circumstances. It is very essential that rose colour should be kept thoroughly dry, as it is much affected by humidity.

Annexed is a table, extracted from those of Brogniart and Salvétat, of the chief points of the change of colour,

and the equivalent heat in degrees of Centigrade and Fahrenheit :—

	Cent.	Fahr.
1. For gilding on delicate grounds . . . . (The colour on the trial will be red-brown, with hardly any appearance of glossiness.)	620	1148
2. Sufficient for touching-up the more delicate colours . . . . (The colours of the trial will be of reddish brick colour.)	700	1292
3. Heat sufficient for touching-up ordinary colours, or for painting on colours previously fired . . . . (The thicker portions of the colour will be brick red, and the thinner parts will be a nice rosy tint.)	800	1472
4. Sufficient heat for painting and decorating for the first time on white ware . . . . (The rose colour will now be inclined to purple.)	900	1652
5. Heat for gilding on white ware . . . . (The rose colour becomes violet.)	920	1688
6. Suitable for heavy gilding . . . . . (The violet becomes pale.)	950	1742
7. Matt gold . . . . (Violet gradually disappearing, and at higher temperatures leaving merely a stain.)	1000	1832

Up to 900 C. or 1,652 F. may be considered to be ordinary kiln heat, but beyond that it would be a hard kiln fire.

The fireman then judges the heat by drawing out the trials and comparing them with those which he has kept from the most successful kilns he has previously fired. He will also carefully . . the intermediate tones of colour on the trials which are suitable to the successful firing of any particular colours which are being used in decoration.

Other colours, such as pale green, may be used in conjunction with the rose-colour as guides, and most firemen have a dash of liquid gold on their trials. Gold should

have, when possible, equivalent heat to rose-colour though it will become brilliant with considerably less ; but if it has had a thoroughly satisfactory fire it should not admit of being removed by hard rubbing with a cloth, and should almost resist the scratching of a knife. The heat of the interior of an ordinary enamel kiln should be of a bright red, inclining towards white, and though not reaching sufficient heat to move the glaze, it is sufficient in a hard kiln to soften it to allow the colours to sink in to a certain extent, and affix themselves firmly to it. As in oven firing the skilled fireman knows from the colour of the interior of his kiln, and by the working of the fire, the heat to which he has attained, this is unfortunately an individual matter, and can only be obtained by experience. If an almost accurate gauge is required, Brogniart's silver pyrometer, as described in Vol. II, p. 674, of his *Traité des Arts Céramiques*, would probably meet the object ; but the trials described will be found sufficient for ordinary commercial purposes.

Firing.—Enamel kilns generally have iron doors though this is not a necessity ; when they have them it is advisable to build a wall of ordinary firebrick three-quarters of the way up inside the door to keep in the heat, and to save the doors. Whenever bricks are used they should be carefully lime-washed. However the doors may be formed there should always be left a spy-hole and a trial-hole. Sometimes there is also a spy-hole in the back of the kiln, which may also be used as a means of escape for steam, &c., when the kiln is first lighted The clamins should never be luted up, or the doors stopped with fire-sand, till some time after the fires have been lighted ; in fact, not as long as the hand can be held in the kiln, so that there may be sufficient heat in the kiln to drive out all the moisture and vapour from oils &c., used in the application of the colours and metals.

Should the fumes be shut in the kiln, the more delicate colours, especially those at the top of the kiln, are almost sure to be affected, and for this reason it is not advisable to fire plates with their face downwards, as they may thus become a sort of receptacle for the vapour rising from below. When the ware is in the kiln the fire should be started slowly to avoid breaking any specially large or thick pieces, and the heat should be a continually increasing one, till the necessary point is reached. Quick, steady firing is what is required, and the fireman must be ready at any moment to stop his kiln, as if the degree necessary to properly fire the colours be passed the result will be disastrous. If the heat rises too fast the brick in the trial-hole may be removed (this is, however, always dangerous and should be avoided, as the admission of cold air is liable to dunt the ware).

In firing enamel kilns it is best to use coal, as slack, though more economical, would be dangerous from fear of sulphur. In firing, there should always be space left for the admission of air in the mouths over the coal, as baiting up to the arch is likely to starve the kiln, and is also ruination to the brickwork, and the kiln will not last half the time it should if this fault be persisted in. If towards the end of firing it is seen that a small baiting extra will be required, care must be taken not to overdo it. When the necessary heat has been obtained, the fires can be at once drawn and water thrown on to put out the fire

It will sometimes be necessary to draw part of the fire, more especially from the back mouth, as some kilns increase in heat enormously after the last baiting has been put on, which is detrimental to many colours, and especially to coral red. A small kiln with one mouth would take about five hours to fire ; a two-mouthed kiln, between six and seven hours, and large kilns with three

mouths eight or nine hours; but, as in the case of ovens, time is only an approximate guide, and must not be relied on. A two-mouthed kiln would require some 12 cwt. of coal to fire it, and a large kiln would consume nearly a ton.

In cooling down a kiln the sand may be removed from the doors or clamins of a small kiln about six hours after the fires are out, and an hour after the doors may be slightly opened, and each half-hour they may be opened slightly wider. Cold air must be admitted most cautiously. In fact, the cooling should go on slowly till the fireman can himself go in, when there is no fear of dunting. When there are very large articles in a kiln the greatest care is required, and the time allowed for cooling should be considerably increased. A two-mouthed kiln should be left at least half an hour longer than a one-mouthed, and a three or four-mouthed longer in proportion.

A Kiln Book should be kept, with particulars as to date, the class of ware fired, the quantity of fuel burnt, the result of the firing, with the percentage of loss, and the value of the ware when fired, with any other details that may be of interest. When drawn every piece of ware must be accounted for in the warehouse, whether spoilt, cracked, or what not. The most common defects in kiln-fired ware are: (1) spitting out; (2) over-firing; (3) under-firing; (4) dunted, (5) chipped, or (6) stuck ware; (7) sulphured ware; (8) or ware soiled by falling dirt or grains.

(1) Spitting out is generally attributed to the ware being damp when going into the kiln. The ware becomes rough and covered with small black specks, and this defect will more often be observed in ware that has been lying in the warehouse some time before being decorated. It is therefore, as a rule, better to decorate ware that has newly come from the oven.

(2) Under-firing will at once be detected, as the colours will be matt, and when rubbed with the finger will come away from the ware.

(3) Over-firing is also very evident; the colours will have a washed-out appearance, and will be in some cases cracked and blistered.

(4) Dunted ware will be caused either by starting the firing too quickly, or by the admission of cold air too soon, or in too large quantities when cooling down the kiln.

(5) Chipped ware will be caused by falls in the kiln, or carelessness in drawing. Both are defects of placing.

(6) Stuck ware is due also to bad placing.

(7) Sulphured ware is either due to the kiln being badly stopped before firing, to insufficient lime-washing, or to a cracked kiln side or bottom during the firing, the latter cause being accidental and unavoidable.

(8) Soiled ware is caused by the kiln, bats, and props not being thoroughly brushed and cleaned before placing, or to too thick application of whitewash, which causes it to scale off and fall during the firing.

Tools.—The fireman will require a punching poker, a rake to draw out his fires, a drawing rod to draw his trials, or tongs for the same purpose, and some pieces of flannel to protect his hands if the ware has to be drawn very hot. He will also require his coal shovel, and a pail for water in case his fires have to be put out very quickly.

CHAPTER XXVIII.

GLOST WAREHOUSES AND GETTING UP ORDERS.

THE number and size of glost warehouses will depend on the amount and class of business to be done. In some branches of the trade it is necessary to hold far larger stocks than in others, and it is therefore impossible to lay down any hard and fast rule. It will, however, be found to be most convenient to keep the different classes of goods as much as possible separate. The white ware in one store, the printed in another, the decorated in another, and so on, the seconds also having a warehouse allotted to them.

The warehouses should be near each other in order to facilitate the "laying out" of orders, and should be furnished inside from floor to roof with penning or shelving, in which any ware that is to be kept in stock or which cannot be immediately packed, may be stored out of harm's way. It should always be put away according to shape, size, colour, and pattern—more especially according to the latter—and when possible it should be placed "in count", so that at any moment the quantity of any one given article or pattern in stock can be ascertained. This is important, as the constant daily movement in earthenware is so great that the work of keeping a stock-book, noting the entry and exit of every piece to and from the warehouse, would be so great that it would hardly be compensated for by the advantages obtained. A rough note, however, of the chief quantities of certain articles is always useful to have by one.

It is needless to say that order is absolutely essential in a warehouse, and when articles are removed from a pen

for any purpose and are not required for packing, they should be replaced in their proper pen, and not be put on the nearest shelf, just to get them out of the way for the time being. Care should be taken that the contents of each pen can be seen, and that the ware in front is not piled up so high, if there be more than one class of article in the pen, that the pieces at the back are hidden, as it may easily happen that the warehouseman may forget where he has placed certain articles, and when wanted for packing they cannot be found, and will perhaps have to be ordered up again. As little ware as possible should be left on the floors, as pieces remaining about on the ground are likely to get chipped or broken, and when ware has been brought in from the oven, if not wanted for packing, it should be put away. Boarded floors are the best in warehouses, as there is less risk of pieces being chipped when they are put down than if the floors are paved, and there is also less likelihood of damp, which is always detrimental to finished ware; warehouses should also be very light, so that colours can be easily distinguished and defects detected.

One warehouse will probably be set apart for "laying out" orders; that is to say, all the ware necessary for any particular order will be brought from the different warehouses and will be put in order on the floor; if complete it will be checked over and it will be sent out to be packed. Should, however, some of the pieces required to complete it not be in stock, it will have to wait till the necessary "shortages" come through the oven. When orders are laid out in this way, a list of the pieces wanted should be placed on each, so that the cause of the delay can always be seen, and the necessary pieces coming from the ovens may at once be added to the lots to which they belong, and the order dispatched. There are many systems of getting up orders in different works, and what

would be admirably suited in one would not work in another ; a rough outline will, however, be given of the way the work should be done, though it must be borne in mind that special circumstances will require special arrangements, and in modern business one must be ready to adapt oneself to the wishes of one's customers, and to the ever-changing conditions of trade.

The orders will be entered up in the office daily in the order-book, whether they come directly from the customers, agents, or travellers. Each order should have a consecutive number attached to it, which should be retained in all departments, and by which it can everywhere be traced.

The order-books should then contain the following details : The number, the date of the receipt of order, the name and residence of the customer, the channel through which the order has been received, full particulars of the quantities, shapes, sizes, patterns, colours, &c., prices, discounts, instructions as to forwarding or shipping. It should also have columns for filling in the number and date of the invoices, and the date on which the goods are sent forward. Each lot of articles will be marked off in the book when dispatched, so that at a glance it can be seen how much of an order has been executed; how much still remains outstanding, and at what interval of time the goods have been sent, without the trouble of referring to invoice, packing or shipping books. This book becomes, therefore, the basis of the business, and it must be most carefully written up and checked, as should a mistake occur here, it will inevitably be repeated all through the works. The orders, also, when ready, will be finally checked before packing by this book, to make sure that the goods are exactly in accordance with the order received.

From this book all the necessary details as to manu-

facture, such as quantity and class of ware, decoration, and observations as to when it is required, including the date and number of the order, will be copied into the warehouse book, and from this point the responsibility leaves the office and rests on the head warehouseman, or whoever is responsible for the "getting up" of the orders, and the office does not again intervene till the goods are ready to be packed.

In some factories the orders are passed on by one head of department to another; let us, however, take it that the head warehouseman is discharging the duty of arranging with all departments, as by this means it is easier to fix the responsibility of delay or mistakes in the execution of the orders. He will first see what ware he has in the glost warehouse towards an order. Anything he has not got, he will go down and order up from the biscuit warehouseman, making the necessary entry in the biscuit-book as to his requirements, with the number of the order. Should the goods not exist in the biscuit warehouse, he will go on to the clay end, and enter up what is required in the foreman of the potters' book, still entering the number of the order. By this means an order can be followed through the whole course of its manufacture, and if the ware does not come through to the glost warehouse in a reasonable time, the cause can at once be traced. If the ware has to be printed, it will be entered in the printer's book; if to be decorated, in the decorator's book; and each head of department will be held liable for the execution of his part of the order.

The details of the method of keeping these different books will vary in accordance with the class of work, and several slight alterations will have to be made till the system most suitable to the work has been evolved; the point to be kept in view being absolute clearness as to

the date of the completion of each order, or part of order, in every department. The biscuit warehouseman, for instance, sends on so many dozen plates to be printed up in such a pattern and such a colour for order No. 100. The printer refers to his book, checks off the quantity and particulars, and if correct, gives out the work to the various printers, and when finished marks it off his book, with the date of execution; in like manner in the decorating department, the biscuit warehouseman sending on the ware for under-glaze work, and the white glost warehouseman sending on the ware required for over-glaze decoration.

The head warehouseman will always have to put a certain percentage extra on to his orders to cover losses in the different processes of manufacture, and different pieces and shapes will require different percentages; but this is soon ascertained in practice, and the necessary allowances made in the various departments. Directly a glost oven has been looked over, the head warehouseman should at once go through the seconds to see what pieces have come out defective, so that he can order up again any that he requires for his orders without loss of time, and the same system should be observed with regard to kilns. The number of the order should also be re-entered in whatever books these shortages are ordered up in.

It is only by strict attention to these details that orders can be got through with dispatch, and it is clear that this is one of the most important points in the business, as not only are customers better satisfied if they receive their goods quickly, but they are enabled to dispose of them and give repeat orders, which means increased business to the factory; if, on the contrary, delay is caused in the execution of orders, the repeat orders would be lost, as it is improbable that customers would order

again till the ware previously ordered had been received, and thus business is lost and the turnover decreased.

It is easy to describe the system by which orders should be "got up", but there are innumerable little difficulties and hitches which will cause delay. It is, however, really not a difficult matter, if the system be thoroughly organised and the work be done hourly without procrastination. A thoroughly systematic man with a good memory will do the work well, but without order chaos and hopeless grief will result. There is nothing more annoying to both manager and master than to see the laying-out floor covered with orders that cannot be packed, owing to the absence of one or two insignificant pieces or covers—insignificant, true, in themselves, but of the utmost importance for the completion of the orders. Warehousemen, like all other people, have to learn their trade, and the more patterns, sizes, and shapes manufactured, the longer does it take to master the various details. A good eye for colour is also of great advantage, as colours, from one cause or another, are sure to vary a little in tone, and it is important to match up the sets with as little variation in tone and as like each other as possible.

The stock in the glost warehouse requires careful management, and should be kept as low as possible. If stock must be held, biscuit stock is the most useful, as it can be applied to any purpose required. There are, of course, certain articles for which there is always a demand, and of which stock may be held with safety; but as new patterns and shapes have constantly to be introduced, and the probability being that a new pattern or shape will kill an old one, it is always advisable to reduce the stock of the old article as much as possible before the new one is introduced into the markets. It is essential that there should be no dead stock, but that it should be constantly

moving off and making way for newer designs. A note should be taken of all articles for which the demand seems to be falling off, and of which there is a stock, in order that they may be pushed and cleared out before the demand altogether fails. Fashion changes quickly, and an article once out of fashion is very difficult to re-introduce, except at a very considerable reduction in price. In some trades the holding of considerable stock is a necessity, and the more stock held the more carefully must it be attended to and looked after.

It is remarkable how stock will increase unless watched, and there are many reasons for a few more pieces coming through than are absolutely required for the orders. The warehouseman may overlook goods in stock and order up again; the percentage alone that he puts on in different departments are sure, sooner or later, to bring through extra pieces. Work is usually given out to the different workmen in complete dozens: this will also give a slight increase over requirements. Often pieces not on order have to be sent through ovens or kilns when there is not sufficient ware of the shapes or colours required for the different parts of the ovens or kilns; otherwise the firing would have to be delayed, and the pieces that *are* required for the orders would be longer coming through.

It is therefore specially important to clear out of stock whenever possible pieces of this class, and to see that they do not unduly accumulate. In fact, to put it broadly, it is necessary sometimes to make certain pieces in order to sell others. It may be considered advisable to keep certain workmen at work, even though there are no orders on the books for the articles they are making. Orders may be cancelled when partly made, or it may be undesirable to send them forward when they are made, for financial reasons; these and many other similar circumstances are all conducive to increase of stock.

Happy is the manufacturer who can so combine his trade as to avoid making stock. One thing is certain: the stock, however good, can hardly increase in value, and from breakage, change in fashion, and competition, it is far more likely to decrease. Breakage is a very serious item, especially where ample warehouse room does not exist, as pieces are piled up too high, and the lower pieces will often be found broken by the superimposed weight.

New articles, when first introduced, fetch a good price, and therefore bring in their train a host of imitators offering a somewhat similar article at a lower price; and though it may not be of so good quality, it is sure to affect adversely the price of the original article. It is a great expense to be continually producing something new, but it is far cheaper than making stock of old articles, which the market is tired of, and which may have to be sold at a considerable reduction, or perhaps have eventually to be cleared out at a heavy loss.

A *Show Room* on some works will be a necessity, especially in places where a large variety of artistic and highly decorated goods are manufactured, and more especially if the works are constantly visited by buyers. On the Continent some of the show-rooms are magnificent, and very great taste is displayed in their arrangement. Nothing is lost by presenting the goods to the buyer in the best possible manner, and the difference between the same articles nicely displayed and huddled together in some odd corner is enormous. Probably goods look worse in an ordinary warehouse than anywhere else; there is always a certain amount of dust on them, and the pieces are arranged merely with a view to facility in working, regardless of the clashing of colours, one decoration practically killing the one next it. Delicate colours look washed out by comparison with some vivid piece of colour by their side, and the vivid colour appears crude

and coarse, judged by the standard of its more sober neighbour. It is only by arrangement and tasté that good effects can be obtained, and the difficulties can hardly be realised till an attempt has been made to procure an effective arrangement.

If no show room should be required, a *Sample Room* will be absolutely necessary, so that a sample of every size and shape manufactured, and every decoration executed on the works, may be kept, and on which the hand can always be laid without having to send to the warehouse to find the piece or pattern required. Besides, it may easily happen that the piece has not been made for some time and the stock cleared out, and therefore it does not exist in the warehouse. A piece may be required at any moment for comparison as to decoration or price with some article sent to be matched, or for which prices have to be quoted, and it is very annoying to find that the piece particularly wanted does not exist, or, at any rate, cannot be found.

If many pieces are made to customers' patterns, a sample room will also be required for these. They should all be numbered, and a full record kept of all details concerning them.

CHAPTER XXIX.

THE PACKING SHED.

Not the least important department on a pottery is the packing shed. When goods have been satisfactorily manufactured, the next object to be attained is their delivery in good condition into the customers' hands. In England far less attention has been given to the delivery of goods than on the Continent, and many manufacturers seem to think that once the goods are off the works, their part of the transaction is ended.

The real way, however, to look at it is from the customer's point of view. How will the goods look when unpacked? and what view will the customer take of the execution of his order? For, after all, one order is of little importance to the manufacturer: what is required is to induce the customer to become a regular buyer, and to imbue him with the confidence that his orders will be promptly and carefully attended to. Different markets require different methods of packing—different customers, even in the same market, sometimes require their goods to be put up in different quantities. It is absurd to send packages which, though easily handled on the works or at railway stations with cranes, are intended for markets where no such appliances exist. It is equally absurd to pack articles in dozens, merely because it is the manufacturer's custom so to do, when the buyer requires them in quantities of ten or a hundred.

These remarks may seem unnecessary, but it is extraordinary the amount of business that is lost through not attending to these matters of detail. Goods that are ordered in sets should always be sent complete. It may

suit the manufacturer to get the pieces off his works as they come out of the ovens, but they are probably quite useless to the buyer. The customer has to sell the goods according to the custom of his market, and the manufacturer, to be successful, must send the goods in the form desired by his customer, and not in the manner that best suits himself.

The packing shed should be dry and arranged in close proximity to the various warehouses, and to the gate of the works from which the goods are dispatched.

However the packing may be arranged, whether by piece work or by day wage, it is essential that the packages should be well filled and no space lost. It is, therefore, necessary, when looking out the packages, that there are sufficient small articles to fill up any large hollow pieces, such as chambers, &c., which is technically called "stuffing". It is manifest that the more ware sent in a package the less will be the percentage on the value of the goods for packages, straw packing, and charges. It will be packed in crates, cases, drums, barrels, and in some cases in baskets or hampers, depending on the different markets for which it is intended, and on the suitability of the ware for the different packages.

It is also necessary that goods should be packed in proper combination; if heavy articles, such as plates, are packed with fragile hollow ware, breakage is almost sure to occur, and once a piece is broken in a package it loosens the packing, and with much movement the breakage is likely to be very large indeed. Good packing is most necessary, as breakage leads to many claims and much unpleasantness.

When the goods are carried out for packing they should be carefully checked from the office with the order book, they having been previously checked by the warehouseman with the warehouse book. A note should be kept of

the contents and number of every package, together with the name or number of the packer who has packed it, so that in case of claims for shortages or breakages the details can be traced. Dry straw should be used, and special goods should be wrapped in paper. Any ware that has been in stock should be cleaned before going to the packing shed, as nothing looks so unsightly when it is unpacked as dirty ware with damp straw sticking to it, &c. Packages for shipment should be made specially strong as they receive such rough treatment when being loaded and unloaded.

The expense of strong packages, even if the customers will not pay much more for them, is repaid again and again by absence of claims and annoyance with customers. Claims, however just, are always a source of annoyance, and both parties are sure to consider they have been hardly treated—the manufacturer, because he knows that the goods have gone as safely packed as it is possible to send them ; the customer, because he considers he should not pay for goods which have arrived in an unsaleable condition ; and it must be owned that the carriers, who are really liable, nine times out of ten escape free, partly owing to the fact that the customer thinks he can make an easier claim on the manufacturer than on a railway or steamship company, and partly because the manufacturer, though admitting no responsibility after the goods have left his works, would rather make some allowance than lose a customer who, he is sure, would not make a claim unless there was just cause for it. Unreasonable people there will always be, and the class of customer who makes a point of starting a claim on receipt of every lot of goods exists in every trade ; these people are, however, soon known, and their complaints treated with the contempt they deserve.

All packages should be clearly marked and numbered,

and it is needless to say that the marks, numbers, and contents of every package should be detailed on the invoice, or on a special note, as in many markets goods are re-sold and passed on without ever being opened; and it is, therefore, essential that the contents of each package should be known. Packers should be kept busy, but probably it will be found better to be slightly over than under manned at this end of the works, as finished goods should be packed and dispatched as soon as possible.

CHAPTER XXX.

ARRANGEMENT OF A POTTERY.

THE first matter that must be taken into consideration is the selection of a site for a pottery, and many factors will enter into the calculation before this important point can be decided. For instance, water power is a great advantage when obtainable. Though, probably, it must not be reckoned of so great importance as it would be in many other manufactures, in potting heat is a necessity for drying the ware, &c. ; and even if steam were not used as the motive power, steam would have to be raised as being the most economical method of heating. Proximity to the sources of primary materials will also have to be considered.

Facility for obtaining fuel must be carefully studied, as the weight of coal consumed on a pottery is greater than that of all the other materials combined, as, roughly, it takes about three tons of coal to produce one ton of finished ware. This calculation, however, takes no account of the sagger marl used, which is in itself a very considerable item, though it might with fairness be advanced that as the marl is often obtained from the coal measures, the balance is all in favour of proximity to the source of fuel rather than to that of the other materials. Situation on the banks of a canal or on a navigable river will clearly have great advantages, both for the carriage of fuel and materials to the works, and for the dispatch of the finished article. Facility as to railway transport will, no doubt, also affect the final decision. All these matters, then, must be carefully gone into before the site for a new pottery can be decided on.

Once the site has been settled on, the necessary buildings will be erected in such a manner that the manufacture becomes a continuously forward moving stream; that is to say, the shops must be so arranged that each operation in the manufacture carries the piece one step forward, and it is constantly moving forward till it is finally packed and dispatched off the works. The stores for the raw materials should be in close proximity to the slip-house, and covered stores will be necessary where large stocks of china clay, dry ground flint and stone are held. Ball clay will be all the better for weathering in the open, though it is always as well to have some under cover ready for daily use close to the slip-house.

Once the clay is made, it should be passed on to the different potter's shops to be made into the various articles required, and these shops should be so arranged that the turners are near the throwers or jolliers, whose work they have to finish. The handlers should also be near the turners, as the latter pass on a large amount of work to the former, to have the necessary handles, &c., applied to it. In like manner the "stickers up" should not be far away from the jolliers, so that the work can be continually sent out to them in proper condition for sticking up.

From the potters the ware will go on to the greenhouse and thence to the biscuit oven. All departments should be so arranged that there is no passing backwards and forwards with ware, but that all ware is always being carried in the same direction forward to the shop where the next process in connection with it is to be carried out. From the biscuit oven it will be passed to the biscuit warehouse, and thence to the dippers, or to the printers and underglaze painters—in the two latter cases it will have to pass through the hardening-on kiln before arriving in the dippers' hands. It will, when dipped, go on to the dippers' drying room, whence it will be

fetched by the oven men to be placed in the glost oven. From the glost oven it will go to the sorting warehouse. The necessary white ware will then be sent on to the enamel shops to be decorated and to be afterwards fired in the enamel kilns, while the printed and white ware that is not to be further decorated will be carried to the various warehouses to be laid out for orders.

The warehouses should be close to the packing shed and also to the gate from which the goods are eventually dispatched. The carpenter's shop, where the crates, cases, barrels, &c., are made may also be conveniently placed near the packing shed. Therefore, on a well laid out works, a piece of ware should start at the clay end, and should continue its course on the works through all its various processes, never retracing its steps, but continually going forward till it eventually arrives a finished piece at the door of the works.

The glaze pans should be close to the lead-house and fritt kiln, and all long distances between one department and the next, where successive processes are to be carried out, should be avoided as much as possible. It is evident that short distances and proper arrangement of departments mean considerable economy, while the carrying of ware backwards and forwards over long distances, at any period of its manufacture, must take up time and increase the cost of production. The sagger-making department should be close to the ovens, so that the green saggers are always to hand when wanted, and the sagger-maker can thus keep an eye on the saggers and note the treatment they are receiving at the hands of the oven men. Sagger marl is also one of the largest items of consumption on a pottery, and it is therefore important that the distance that the materials, either in the finished or unfinished state, have to be carried should be as short as possible.

All the streets on the works should be kept clean and in good condition, and they should be well drained, so that water does not stand about in them after rain. If not properly drained, when wet, the streets will always be dirty and muddy, and everyone going into a shop or warehouse will carry in unnecessary dirt with them. Cleanliness must be studied everywhere, and every precaution must be taken to prevent the introduction of dirt into any department. There should be receptacles placed at fixed points for the reception of refuse, and no rubbish should be allowed to be thrown about either in the shops or anywhere on the works. Sanitary arrangements will require careful attention, and should always be inspected from time to time.

Light is of very great importance, and defective light is almost certain to cause defective ware, and in no department is this, perhaps, so apparent as in that of the turners. A liberal use of whitewash both lightens and freshens up the workshops. Every door should be numbered and its corresponding key should also be numbered and labelled, and a list, giving particulars as to each key, should be hung up in the place where the keys are kept, so that if after work it is necessary to go into any shop the key can at once be found without any trouble. These small matters of detail, though apparently of no importance, will often be found of great assistance and convenience.

The manager's office, if possible, should be situated in the centre of the works, so that he is in touch with every department, and the store for colours and small articles of everyday requirement may conveniently be attached to it. If coal is stocked in considerable quantities, it is evident that the nearer it can be stored to the ovens the better. The position of the boilers must also be studied, as it will generally be found more economical to have large boilers

from which all the necessary steam for engines, printers' tables, potters' or dippers' stoves, &c., can be supplied, than to have smaller boilers distributed about for these various objects ; as not only will the consumption of fuel be greater, but more men will be required to attend to them. It will, therefore, be necessary to have the steam-using departments as near the boilers as possible, to avoid long transmissions through pipes, by which both power and heat are lost. Boilers must, of course, be tested from time to time, in order to detect any weakness.

All stoves or drying rooms should be arranged close to the workmen, the doors, if possible, being exactly behind them when working at the bench. The proper warming of drying rooms is very important, and the more heat that can be supplied the better, as it not only augments the production of the workman, but it increases the duration of the moulds. Whenever ware has to be taken from one shop to the other, or from the shops to the kilns, it should be carried, whenever possible, under cover, as in wet weather drops of rain falling or splashing on ware will often cause serious defects, and this will be found to be specially the case in any unfired overglaze painting with delicate colours. Clay ware is also likely to suffer, as the moisture is absorbed into the clay at different points, and if sent on to the biscuit oven the contraction will be different in different parts and the piece will probably become crooked.

The mould making, engraving, and modelling departments may often equally well be placed in different parts of the works, though the former should, for convenience, be handy to the potting shops.

The Sample Room and Show Room should be in a convenient situation near the entrance, as also the General Office.

CHAPTER XXXI.

GENERAL REMARKS.

It will have been seen from the foregoing notes that the manufacture of earthenware is made up of details, and for the successful management of the business it is absolutely necessary that all these varied matters should be looked into most carefully. No matter how apparently insignificant the defect, it must at once be corrected with the greatest care. Nothing which is likely to lower the quality of the production must be allowed to pass without remark, whether in clay, glazing, printing, or decoration.

It must be always remembered that the pieces pass through a considerable number of hands, and if defects, however small, occur in two or three of the different processes, the piece, when finished, is defective in several points and becomes a seconds instead of a firsts, and its value is considerably lowered. The expense of producing this seconds or defective piece is exactly the same as that of producing a firsts, and too many seconds are made by circumstances over which one may say one has no control, to admit of seconds being produced by carelessness. Besides, if one is continually on the watch a mistake is found out or a defect is observed in the first few pieces made, and can at once be pointed out and corrected, whereas if matters are allowed to go on without sufficient supervision, dozens of pieces may pass through the whole of their processes only to be found useless, or unsuitable for the purposes for which they were originally designed on their arrival in the finished warehouse.

The manager will probably find it convenient to have certain fixed hours in which he may always be found in

his office. By this means he will save his own time, as he will not be troubled by people continually coming to ask questions out of the appointed hours, and foremen's time will be saved, as they will not be running about the works looking for the manager, knowing that he is always to be found at stated times at his office.

The management of every business must vary according to circumstances, but it will generally be found to be a mistake to make too many different shapes, and a multitude of patterns and forms should be avoided as much as possible. When colours have once been hit on that may suit the trade, they should be kept to and followed as closely as possible, and no alterations should be made in them, as if once an alteration be made to suit the whim of some particular customer, there will be different tones of colour coming into the warehouse, and mistakes will most probably result. In fact, if customers require special colours, they must be prepared to pay an extra price, as the manufacturer will, sooner or later, find himself with pieces on hand which he cannot apply to his ordinary trade.

Strict discipline and rigid attention to the rules of the works must be enforced, and the larger the works and the more hands employed the more necessary will it be found to enforce discipline. It is, therefore, very necessary to avoid making rules which cannot be enforced or carried out. Workmen should not be allowed in each others' shops, but should be kept strictly to their own departments, and there should be no continual running about the works. The fewer people that are seen walking about on the works the better, as it is a sure sign that everyone is better employed than in running about. Times should be fixed for counting the ware and for giving out stores, colours, printing paper, &c., and should be strictly adhered to. A head should be appointed in

each shop, and he should be held responsible for the cleanliness, order, and proper management of that shop.

As the business is a mass of details, and it is necessary in the manufacture to look after every little defect, so is it necessary to look out for little leakages in expenditure. It is wonderful what a lot of waste may go on in little driblets in various parts of the works in clay, colour, press cloths, oil, turpentine, and a hundred and one other things that are used during the manufacture ; and it is often attention to these apparently insignificant details that will make the difference between a profit and a loss at the end of a year ; and it is surprising how the account for small stores, odds and ends, &c., mounts up in the course of a year.

A careful account must be kept of all repairs done during the year, as this is another account that quickly mounts up. Small improvements must be carefully noted. A new door here, a new window there, a bit of stillaging in one shop, a bench in another—there is always something that wants doing to facilitate work and to economise space. Oven and kiln repairs, which are almost continuous, should be kept in a separate account, as also repairs to machinery and plant. Economy must be the goal in view in every department, not only by preventing all waste and unnecessary expenditure, but by the proper arrangement of the work and the saving of labour whenever possible. All books should be kept written up to the day, and no work should be put off till to-morrow that should be done to-day; there is probably no business in which time is such an important factor as in potting. Ware has to be dried, ovens and kilns have to be fired, and these processes require their regular fixed times, and it is impossible to shorten them by an hour. Therefore, if an oven is not got in on the day fixed for it, but has to wait over till the next day before it can be closed up

and fired, no amount of activity afterwards can ever make up for the day lost. A day or an hour lost on a factory can never be recovered, and this is one of the important facts that must be always borne in mind. Everyone, therefore, must do their work exactly to time, and the putting off work and not doing it at its appointed time should be looked upon, in any department, as a very serious offence.

A pottery is like a watch, and a stoppage in any part of it acts like the stoppage of a wheel in the watch, bringing the whole organisation to a standstill. One must, therefore, always be on the look-out for weakness in any part of the organisation, so that should it fail it may be at once strengthened, as, no matter how strong the rest of the departments may be, if there is failure in one, it will be felt everywhere. The strength of a chain is only that of its weakest link.

Cost of production should be carefully calculated out and prices should be fixed accordingly, and should never be based on what other manufacturers can do. Because one manufacturer is selling at one price, it does not follow that another can do the same. Owing to certain combinations of orders, the one may be able to produce some articles cheaper than the other. On the other hand, the other may have facilities for producing another class of article, but it is clearly necessary to know what each article costs, and then if special large lines are offered to be executed at exceptional price, it can at once be decided if they should be accepted or not; for cheapness tempts the million, while unfortunately super-excellence of workmanship and goodness of material appeal to the few only.

Large orders are always attractive, as they make a certainty of work in advance, and one is far more likely to take a large order at an unremunerative price than

a small one, so that quotations for these especial orders require most careful attention, as the consequences, in case of error, will be serious.

Stocktaking must be carried out systematically at the end of every year, or every six months if necessary. Attention is thus called to any odd lots of ware which are not moving off, and steps must be taken to clear them out. Not only must stock be taken of the ware, but of every article in use on the works, deductions being made for depreciation of boilers, machinery, and plant generally, and a value put on any improvements or new implements purchased during the year. No doubt it takes a little time to do this thoroughly, and work may have to be suspended in some departments, but it is absolutely necessary, and the time is well spent, as the cost of production can only be ascertained accurately by attention to every item of expenditure.

To sum up briefly, the objects the potter must always keep in view are—good quality, cleanliness, order, system, and attention to detail. Much useful information can be obtained from books, and sound technical knowledge and a good insight into chemistry are absolutely necessary for the modern potter; but these are quite useless without practical knowledge and actual experience; for, without doubt, the trade can be only learnt "at the mixing ark, the dipping tub, and the oven mouth".

APPENDIX.

CALCULATION OF COST OF PRODUCTION.

In order to fix the price of a manufactured article, it is necessary to know what it has cost to produce it. In the manufacture of earthenware this is all the more important, as the selling price of each individual piece is so low that a slight excess of cost in any one department may cause a loss on its sale. The processes through which it passes are so many and so varied that, if a business is to be worked at a profit in these days of keen cut prices, it is essential to know the cost of its progress through each department in order to check waste and to see that value is received for the money spent. It seems difficult to fix the exact amount spent in the production of one small article, such as an egg-cup, but if all expenses and charges are carefully tabulated the cost can be arrived at with considerable accuracy, and by taking each group of expenses together it often draws attention to excessive expenditure in one article as compared with another in the same department, owing to faulty combinations or methods of manufacture; and in no department is this more likely to occur than in the ovens.

The system of calculation that will suit one factory may not be convenient in another, so it is proposed to give a rough outline of how the cost of production may be arrived at, leaving it to each individual to augment or curtail any details as may be most convenient in his own particular case.

Broadly, the principle is to take every expenditure, both of materials and reproductive labour, and then add

on a percentage to cover cost of management, rent, travelling expenses, &c., insurance, lighting, and taxes, warehouse work, looking over biscuit and glost—in fact, all work which is not absolutely part of the production —though if considered desirable, as already mentioned, each one can keep any one of these charges separately ; finally, a percentage must be added for profit.

We will suppose we are dealing with a factory arranged with modern machinery and appliances, so that the first expense to be considered will be steam-raising. We must therefore calculate the interest and depreciation on boilers and engines, consumption of fuel, water, oil, cotton waste, packing, tools, &c., and the wages of the men attending to them. The probability is that steam will have to be divided up into different departments—slip-house, jigger, shops, glaze pans, colour pans, mills, printing stoves, &c. Mills may have to be subdivided under various heads if different materials are ground, such as fireclay and grog for saggers, flint and stone for body, plaster stone for plaster, bitstone for placing, &c. We may take the total cost of developing so many horse-power of steam, and then allot the necessary proportion of horse-power to the different departments as they may require.

Having obtained the cost of steam, let us first proceed to the slip-house and work out the cost of the body. As several materials at different weights and of various prices are mixed together, it is first necessary to get at the amount of each material used and its value.

The simplest method is to take a pint of each of the materials in the slop state at the weight at which it enters into the composition of the body, after it has been passed through the lawns. First pour them into moulds and when sufficient water has been absorbed, remove the materials and thoroughly dry them before a fire, or in an ordinary kitchen oven, till all the moisture that can be

extracted has been driven off. Each material is then weighed, which will give the amount of dry material of the various substances in each pint of slip. To arrive at the value of these various materials, it is necessary also to bring the materials as originally purchased to the same state of dryness, as all these materials, when sold commercially, contain a considerable amount of moisture in varying quantities. To obtain accurate results it will, therefore, be as well, if possible, to dry both the materials as purchased and the materials extracted from the different pints of slip, under the same conditions, just before they are weighed.

Ball clay, when dried in this way, will lose some 20 per cent or more of its weight; china clay about 12 per cent. Flint, when bought in the dry state, will lose about 3½ per cent, and stone, under the same conditions, about 6 per cent. These percentages will vary considerably, according to the conditions under which the materials have been received. Ball clay, for instance, will contain more moisture in winter than in summer, especially if weathered in the open. Flints and stones, when bought dry, will vary in accordance with the amount of water that has been driven off after they have been ground. In fact, all materials should be tested for moisture, as should they contain an excessive quantity the buyer will be paying for water instead of material. If flint and stone are bought in the slop state a pint of each should be treated and dried in the way described. The quantity of dry material in a pint of stone will be found to vary largely, owing to the diversity of the different qualities of this material.

A deduction must always be made for the dirt, &c., extracted during the process of lawning, and probably something between 1½ to 3 per cent will cover this, though it depends largely on the size of the lawns used and the cleanliness or reverse of the clays, &c. Once having

deducted the percentage of water, the true cost of the material dry can be calculated from the invoice.

The mixing ark must now be measured up, and the number of pints in each inch of depth calculated; then we have so many inches depth of each material, which equals so many pints, containing so many ounces of dry material, at such and such a price.

A small experimental ark may also be made, and the mixing carried out with a few pints of the different materials; and in this case, if considered desirable, the whole amount of slip may be dried and weighed up again.

The wet mixing may also be reduced to a dry mixing, and the calculations made on the whole amount of material, by deducting the percentages of excessive moisture in the materials as received from the furnishers, or the proportion may be calculated according to the specific gravities of the materials in the slip state.

The amount of stain with its cost must next be calculated. A pint of stain at the weight at which it is used must first be dried to obtain the dry material in it, and the proportion of cobalt, flint, stone, &c., that enter into its composition must be arrived at, together with the cost of calcining, including loss and flinting saggers, &c., together with the cost of grinding, lawning, and labour.

Many tables and calculations for these processes have been published from time to time, but those published in the *Manual of Practical Potting* (Scott, Greenwood and Co.) will be found both useful and concise.

Having obtained the value of materials used in each mixing, the cost of water must be added. The value of the machinery in the slip-house must then be obtained to calculate interest and depreciation, including upkeep of magnets, lawns, press cloths, taps and stand pipes, buckets, brushes, sponges, tools, &c.; and to this must be

added the proportion of cost of steam-power, together with oil, cotton waste, pump rings, washers, and packing, &c., insurance, rent, or interest on capital of freehold and structural repairs, lighting, and taxes, and, finally, loss in the various processes. Something should be charged for management, when making up the cost of the body, but in calculating the cost of individual pieces it will be found more satisfactory to put a percentage on to cover cost of management during all the processes together, rather than to allot something for management to each process ; the same rule may also well be applied to taxes, insurance, rent, repairs, and general charges.

Having now the cost of the body, we have merely to extract the moisture from a pound of pugged clay, in order to obtain the amount of dry material in it and its value. We thus have the cost of a pound of pugged clay, and by weighing up any piece in the clay state we obtain the value of clay in it. Roughly, a good body ready for use, under present circumstances, will have cost about £2 per ton.

The next department to proceed to is that of mould making, as in modern earthenware manufacture the cost of moulds enters into the cost of production of nearly all pieces. The cost of plaster must first be ascertained, and if manufactured on the premises, the various processes of boiling, grinding, lawning, must be gone through till the cost of it in the mould-maker's shop has been arrived at. Then the cost of plant, interest, repairs, &c., wages, &c., as in the slip-house, must be added. Each mould must then be weighed and its value ascertained. To these amounts must be joined the proportion for modelling and blocking and casing, which form heavy items in the mould-making expenses. It is also necessary to know approximately the number of pieces that can be made off each mould. This can only be obtained practically by

noting how long "a round" of moulds lasts, and the amount of ware produced off them in that time.

We next proceed to the clay-shops, and again make a calculation for the machinery, including interest, depreciation, and repairs, both on machinery and plant, such as steam, ropes, stoves, boards, tools, files, &c., adding on the cost of steam-power allotted to these particular shops. All the expenses should then be divided amongst the different machines, taking into consideration that some of the machines are not always running, and so are not always producing. We thus arrive at what it costs to run each individual machine daily. To this must be added the cost of labour, whether day wage or piece work. The total divided by the number of pieces made during the day off any one machine, plus any expenses incurred for handling, turning, fettling, or sticking up, will give the cost of making, which must be added to the value of the clay in the piece to obtain the cost of the article up to this stage in the manufacture. The piece, after being looked over, passes to the biscuit oven.

It will now be necessary to calculate the cost of sagger making, including steam-raising, interest and repairs of machinery, grog grinding, clay making and pugging, &c., upkeep of drums, tools and wages, till the cost of a "common height oval" sagger 20 in. × 15 × 8 is obtained, as this is generally used as the standard by which all firing calculations are made. Other systems are in use, such as taking the cubic space in a sagger and calculating the costs per inch cube, but the most practical is the common height sagger, as when in any difficulty the pieces can be tried in the sagger itself, and there is then no doubt as to how many pieces can be placed on it. It is also necessary to know the number of saggers destroyed in every firing, and this again must be obtained by actual experience, as ovens vary so. The foreman of

the placers should give in a return after every firing of the number of saggers which have been destroyed, and these should be entered up in the oven book, so that at the end of the year the average saggers destroyed per oven may be checked.

In firing an oven the following items must be taken into consideration :—

Interest or rent of ovens and plant, such as barrows, baskets, ladders, pokers, drawing-rods, buckets, boards, fire-bars, &c. Repairs to brickwork.

"Ridding" (a new bottom) once every three years, and a new oven every twenty years.

Saggers, placing sand, or wad clay, if used. Coal.

Wages for placers for setting in and drawing, firemen, and sitters up.

When all these charges and other expenses in connection with the biscuit firing have been obtained, they must be divided by the number of "common height" saggers that can be placed in the oven, which gives the cost of firing one common height sagger. Therefore, to obtain the cost of firing in biscuit, the cost of firing a common height sagger must be divided amongst the number of pieces that can be placed in it. If a taller or wider sagger is required for certain pieces, it is reckoned as one and a half, or one and a quarter, common height saggers; if a lower sagger is required, then it is reckoned as a one-half or two-thirds of a common height sagger. By this means a different price for every sized sagger is avoided, and calculation is facilitated.

If the piece is to be sold in white the next process will be to glaze it, and for this purpose the cost of the glaze must be worked out. First, interest and repairs of fritt kiln (the latter being an item usually considerably under-estimated). Utensils and plant must also be taken into consideration. Then the cost of the various ingredients—

borax, boracic acid, soda ash, flint, whiting, china clay, lead, stain, &c., &c., water for cooling, coal, and labour. The yield of fritt will be some 25 per cent to 33 per cent less than the quantity of the original materials; this will, of course, vary with the mixture used, but must be taken into account before the cost of the fritt per lb. can be arrived at.

The cost of the mill mixing must then be ascertained by taking the value of the fritt, stone, flint, lead, &c., added to the cost of grinding, if this is done on the works; interest on mills, depreciation and repairs, oil, re-picking stones, wages, &c., must be taken account of, and there must also be a small deduction made, both in fritting and grinding, for losses and leakages during the various operations. The quantity of glaze used in the actual operation of dipping each piece can again only be obtained by actual experiment. The dipper will generally dip the greater part of the ware in the same strength of glaze, so that a pint should be taken from the tub and weighed and then dried, in order to obtain the value of the material in a pint of glaze at the weight the dipper is using it.

The number of inches in the dipper's tub—which must be an upright one and not conical shape, or the quantity contained in each inch of the tub would vary—should be measured. Or if this is not feasible on account of the shape of the tub, the glaze can be measured in, gallon by gallon. So many dozens of any article can then be sent in to the dipper, and when he has dipped them the glaze is again measured, either by inches or by gallons, care being taken before measuring it that the glaze has been brought back to the same weight per pint as at the commencement, by adding some water to compensate for the excess that has been extracted in the operation of dipping. The result will then be that

it has taken so many pints, containing so much dry material, worth so much, to dip a given quantity of ware; to which again must be added labour for dipping and cleaning off, and interest and repairs on utensils and tools, &c., in the dipping shop.

If white ware is the article to be priced, glost firing will be the next process, and the cost must be treated in the same way as in biscuit firing, the common height sagger again being the unit. Sagger wash, wadding and stilts, thimbles and bitstone must be included, but no sand will be required as in biscuit placing.

If the ware is printed, then the cost of printing must be gone into, which would include steam, interest and repairs on presses, stoves and plant, wear and tear to copper plates, and cost of engraving, paper, colour, oil, flannel, string, turpentine, &c., tools, if supplied, water for washing off, and then the labour must be added. The consumption of paper and colours will vary with different patterns, and the cost can only be arrived at by practical trials—in fact, by giving out fixed quantities of materials and having a return of all work done with them—and a note should be kept of the duration of a set of flannels, and the quantity used during the year will also act as a guide. The same remarks apply to painting underglaze, the cost of which must be gone into, pattern by pattern. To these expenses must then be added on the cost of hardening-on kiln, including interest and repairs of kiln, labour, tools, and coal, and by counting the contents of a kiln a time or two, the average number of dozens can be ascertained and the cost per dozen calculated. For overglaze work the same system must be adhered to, but even greater care must be observed, as the colours, &c., are considerably more expensive, and the contents of every kiln will be counted and valued, and entered in the kiln book.

Interest and repairs on kiln will again be the first charge, and the repairs are no small item, as an enamel kiln should be looked over every firing; then labour, utensils, colours, gold, &c. A return should be kept of all work done with gold, and it should be weighed out with the utmost care to check any waste.

Having gone into all the expenses of the actual production of the pieces, it will be necessary to put on a percentage to cover all other expenses that have not been taken into account, such as management, all work in warehouses, clay, biscuit, and glost, looking over and sorting, &c., office work, travellers, special discounts, bad debts, rent, taxes, insurance, &c.; in fact, all expenses and general charges of every kind which have not been already included, except such charges as are paid in full by customers, such as packing; though should a loss be incurred on this department, that loss would also have to be included. Many of these charges may vary from year to year, and it is clearly necessary to analyse the accounts every year in order to ascertain what percentage on the production the cost of these different departments really is, as apart from it enabling one to form a more accurate calculation of cost, it draws attention to the increase of expense in any one department, or to the economy effected in another.

It seems a rather complicated system to embark on, but once in working order the difficulties vanish, and every detail collected serves as a check on some part of the calculations—till, eventually, one can establish certain rules of comparison between the consumption of materials, labour, cost of firing, &c., which serve as wonderful guides in calculating cost, and often enable one to arrive at a very near guess at the cost of production of an article before any calculations have been gone into; and the more accounts can be analysed at the end of the

year, and the more percentages of various expenditure that are taken out, the more accurate will the calculations of cost become, and the more intimate will the knowledge of the working of the business be.

A book may be kept in which all articles may be tabulated in alphabetical order for facility of reference, and something like the following system may be adopted :—

Article.	Size.	Piece or dozen.	Clay.	Moulds.	Making.	Machinery.	Biscuit fire.	Glaze-dipping.	Glost fire.	Percentage for management, unproductive labour, taxes, &c.	Cost white.	Do., with profit.	Printing.	Colours, &c.	Copper plate.	Kiln.	Percentage for management, &c.	Cost printed.	Do., with profit.	Painting.	Colour.	Gold.	Special decoration.	Number of pattern.	Kiln.	Percentage for management, &c.	Cost.	Do., with profit.

Each column explains itself ; the most difficult amount to arrive at is the percentage for management and all other charges ; but each year, as the accounts are studied,

this may be checked so that the expenses are fully covered. In making out the cost of printed or decorated ware, the cost of printing or decorating must be added to the cost of the white ware, without any charge for management or profit, and then the amount of these two charges must be calculated on the whole. A column or two may be used for any special decorations, and if all decorations are numbered, the number may be placed in the column, which at once shows what decoration is referred to.

There is one very important matter which must be kept in mind through all these calculations, and that is, that a "dozen" varies in the number of pieces it contains in different factories, and in the different processes in the same factory; and the same article may count six to the dozen in one department, nine in another, and twelve in another; or again, twenty-four to the dozen in one department and thirty-six in another. In fact, the safest basis to go on is to start with the supposition that a dozen is anything but twelve. The object of these different counts is to facilitate payment for work done, and a man is often paid the same amount for dozens of articles of quite different size, and therefore necessitating a longer or shorter time to make them. The price remains the same, but the quantity of pieces in each dozen alters in accordance with the work and time required to produce them. Great care is therefore necessary in calculating cost to be sure of the number of pieces that correspond to the amount paid per dozen.

There ought also to be a certain allowance made for seconds; this can only be learnt by experience, and probably the easiest way of dealing with it is to allow for it in the firing in the different departments, should it be considered undesirable to increase the number of columns.

Other special books may be kept with advantage to guide in the calculation of cost, such as oven and kiln books with details and results of every firing; materials book, showing the exact cost on the works, including all charges for cartage, loading, &c., of every material used in the manufacture, so that the cost of any article may be seen at a glance. In every branch of the trade, in fact, certain details will be required to be kept apart, so that each one must decide what special books will be required for his special circumstances, and what may be judiciously suppressed. It is evident that a cost book as above described will be of the greatest use in deciding whether certain orders should be accepted at special prices, or whether it would be better to leave them alone; and if a manufacturer does not know what it costs him to produce an article, how can he possibly know at what price he can sell it?

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